With METALLURGICAL SUPPLEMENT.

The Engineer.

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PUBLIC NOTICES.

REFRIGERATION.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 15th September, 1931, for the SUPPLY and ERECTION of REFRIGERATING EQUIPMENT at Broadmoor Asylum, Crowthorne, Berks.

Drawings, specification, a copy of the conditions and form of contract and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7439

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HEAD OF DEPARTMENT: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1931-32.
(Commencing on MONDAY, 5TH OCTOBER, 1931.)

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W. J. WILLIAMS,
Director of Education.
City Hall,
Cardiff. 7433

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WINTER TERM BEGINS on WEDNESDAY, SEPTEMBER 9th. 7455

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The Engineer

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The Polytechnic, Regent
STREET, W. 1.
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President of the School: Sir JOHN THORNYCROFT, K.B.E., M. Inst. C.E., M.I.N.A.
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Head of Mechanical Engineering Dept.: R. F. THOMPSON, B.Sc., Hons. (Eng.), M.I. Mar. E., A.M.I. Mech. E.

The DAY DEPARTMENT REOPENS on SEPTEMBER 15th, 1931. Entrance Examination commences September 8th, at 10 a.m.
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University of Manchester.

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DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

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The SESSION COMMENCES on THURSDAY, OCTOBER 8th. 7397

PUBLIC NOTICES.

University of Manchester.

PHYSICS DEPARTMENT.

Full particulars of the Lectures and Laboratory Courses in Physics, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on THURSDAY, OCTOBER 8th. 7398

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SECRETARY OF THE COLLEGE,
35, Lincoln's Inn-fields, W.C. 2,
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SUNDERLAND TECHNICAL COLLEGE.
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HERBERT REED,
Chief Education Officer.
Education Offices,
15, John-street, Sunderland,
19th August, 1931. 7402

PUBLIC NOTICES

County Borough of Croydon.
EDUCATION COMMITTEE.
CENTRAL POLYTECHNIC—MECHANICAL ENGINEERING DEPARTMENT.

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R. B. MORGAN,
Education Officer.
Education Office, Croydon. 7428

Government of Northern
IRELAND.
NOTICE TO CONTRACTORS.

The Ministry of Finance invites TENDERS for the INSTALLATION of a WATER TURBINE at the Ulster Dairy School, Cookstown, Co. Tyrone.

The plan and specification can be seen and form of Tender obtained at 13, Ormeau-avenue, Belfast (Room 20). Each Tender must be for a lump sum and be accompanied by detailed quantities and prices. The envelope containing the Tender is to be addressed to the Secretary, Ministry of Finance, 13, Ormeau-avenue, Belfast, and marked "Tender for Water Turbine." Tenders will be received up to, but not later than, 3 p.m. on the 8th day of September, 1931. The Ministry is not bound to accept the lowest or any Tender. Preference will be given to firms on the King's National Roll.

R. E. THORNLEY,
Assistant Secretary.
Ministry of Finance, Belfast,
26th August, 1931. 7462

TO CONTRACTORS.

North Norfolk Rivers Catch-
MENT BOARD.
DIVERSION OF HEACHAM RIVER OUTLET.

The North Norfolk Rivers Catchment Board are prepared to receive TENDERS for the CONSTRUCTION of a CONCRETE CULVERT, 92 yards long, through the Foreshore at Heacham for the purpose of Diverting the Heacham River.

Copies of the form of Tender, general conditions of contract, specification, bill of quantities and drawing may be obtained on application to the Engineers, Messrs. Lewis and Lewis, 15, Victoria-street, Westminster, S.W. 1, on and after the 25th day of August, 1931. Applications must be accompanied by a deposit of £1, which will be refunded after the receipt of a bona fide Tender and the return of the drawing to the Engineers. Copies of the drawing and documents may also be seen at my office.

Tenders, which must be made on the form supplied, are to be forwarded, together with a signed copy of the documents, with the bill of quantities, fully priced out in a sealed envelope, endorsed outside, "Tender for Heacham River Outlet." The sealed envelope is to be enclosed in an outer envelope and delivered to me at my office, Fakenham, Norfolk, on or before Monday, September 14th, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

F. ANDREWS,
7434 Clerk to the Board.

Metropolitan Water Board.

TENDER FOR THE MANUFACTURE, DELIVERY AND FIXING OF ONE SWITCHBOARD FOR TWO 200 AND ONE 50-KILOWATT D.C. GENERATORS, &c., AT SURBITON PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY and FIXING of ONE SWITCHBOARD for Two 200 and One 50-Kilowatt D.C. Generators at their Surbiton Pumping Station, Portsmouth-road, Surbiton, Surrey.

Forms of Tender, conditions of contract, specification and drawing may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 173), on and after Friday, 28th August, 1931.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of One Guinea, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawing. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Switchboard, Surbiton," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Thursday, 17th September, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
25th August, 1931. 7442

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Metropolitan Water Board.

TENDERS FOR THE MANUFACTURE, DELIVERY AND ERECTION OF ONE VERTICAL HIGH-COMPRESSION HEAVY OIL ENGINE WITH 500 K.W. D.C. GENERATOR, SWITCHBOARD AND APPURTENANT WORKS AT HAMPTON PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY and ERECTION of ONE VERTICAL HIGH-COMPRESSION HEAVY OIL ENGINE with 500-kW D.C. GENERATOR, SWITCHBOARD and APPURTENANT WORKS at their Hampton Pumping Station, Hampton-on-Thames, Middlesex.

Forms of Tender, conditions of contract, specification and drawing may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 173), on and after Friday, 28th August, 1931.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of Two Guineas, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawing. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Vertical Oil Engine, Hampton," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Thursday, 8th October, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
25th August, 1931. 7441

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF CAST IRON STRAIGHT PIPES.

The Metropolitan Water Board invite TENDERS for the SUPPLY of CAST IRON and SPUN IRON SOCKET and SPIGOT STRAIGHT PIPES for the periods of Six and Twelve Months commencing 1st October, 1931.

Tenders must be submitted on the official forms (Tender No. 3), which may be obtained from the Chief Engineer by personal application at the Offices of the Board (Room 155), or upon forwarding a stamped addressed sack envelope (14in. by 9in.).

Tenders, enclosed in sealed envelopes addressed to the Clerk of the Board, and endorsed "Tender for Cast Iron Pipes," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 14th September, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
18th August, 1931. 7423

Metropolitan Water Board.

MAIN—OAKLEY-ROAD TO BROMLEY COMMON.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of approximately 3833 lineal yards of 18in. diameter CAST IRON MAIN, and the TAKING UP of about 1310 lineal yards of 12in. diameter CAST IRON MAIN, together with CONNECTIONS and CONTINGENT WORKS, from the South end of Oakley-road to Crown-lane, Bromley Common, in the Borough of Bromley.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 31st August, 1931, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 Noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed "Tender for Main, Oakley-road to Bromley Common," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 21st September, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
12th August, 1931. 7409

The Civil Engineers Appointments Board,

9, Princes-street, Westminster, S.W. 1, acting under annual licence from the London County Council, invites ENQUIRIES from EMPLOYERS SEEKING the SERVICES of PROFESSIONAL ENGINEERS, either as Assistants or in more responsible positions.

All those whose names are accepted for entry in the Board's Register for employment possess qualifications which have been attested by means of scientific examinations, practical training and experience. P1305

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PATENTS

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The Salford Electricity Undertaking.

THE report issued by the chief electrical engineer at Salford for the year ending March 31st, 1931, shows that during the year 1615 consumers, representing 10,808 kW, were connected to the mains, making a total of 16,968 consumers with 102,787 kW, an increase of 10·5 per cent. in consumers and 11·8 per cent. in kilowatts. Three hundred and nine motors with an aggregate capacity of 1956 horse-power were connected to the network, bringing the total number to 4809 with an aggregate of 52,134 horse-power, an increase of 6·1 per cent. in motors and 3·9 per cent. in horse-power. An interesting list included in the report shows the number and the horse-power of motors used in various trades, and indicates that the engineering trades use electric power to a greater extent than other trades. The total number of motors used in engineering workshops at the end of the year covered was 727, with an aggregate output of 7453 horse-power. From the point of view of horse-power connected, the docks come next on the list with a load of 7203 horse-power, although in this case there are only 397 motors. The maximum load on the station during the year was 27,000 kW and the load factor was 33·3 per cent. The total number of units sold, including those used to the tramways, was 65,924,996. Compared with the previous year, lighting units showed an increase of 3·3 per cent., the units sold under the all-in domestic rate 32·7 per cent., street lighting 141·7, power a decrease of 5·4 per cent., heating an increase of 9·5 per cent., and tramways a decrease of 2 per cent. The increase on the total units sold was 1·04 per cent., or exclusive of the tramways 1·8 per cent. The number of consumers changed over from D.C. to A.C. during the year was 630, compared with 236 during the previous year, making a total of 2903 consumers changed over to the A.C. supply.

The Brimsdown Extra High-Pressure Alternator.

AFTER three years' working in the Brimsdown Station of the North Metropolitan Electricity Supply Company, the Parsons' extra high-voltage turbo-generator set has been opened up for inspection both at the steam and electrical ends, and a few days ago we had an opportunity of examining the windings whilst the alternator end covers were removed. They proved to be in perfect condition and showed no signs of deterioration as the result of service at the exceptionally high pressure for which the machine is designed. Although the Brimsdown alternator was originally intended to generate at 33,000 volts, we understand that it has been working at 35,000 volts, and that another high-pressure Parsons' alternator, to be installed at Brimsdown, will be designed for 36,000 volts. The fact that Captain Donaldson, the chief engineer to the North Metropolitan Electricity Supply Company, has ordered another of these high-pressure alternators is a pretty clear indication that the original machine has given satisfaction. Notwithstanding that soon after the alternator was put into service a considerable amount of trouble was experienced with the overhead lines and 33,000-volt cables and very heavy faults occurred on the system, the machine came to no harm. It is said that, although the reactance of the generator is almost the same as that of an ordinary low-voltage alternator and transformer, the parallel operation of this 33,000-volt machine is exceptionally stable and the Brimsdown engineers are loud in praise of its general performance.

Oil-Electric Traction for Railways.

PROPOSALS for the adoption of the oil-electric system of traction on British railways as a possible alternative to the main line electrification scheme outlined in the Weir report, were placed before the Minister of Transport, the Chancellor of the Exchequer and other members of the recent Labour Government shortly before its resignation. The statement referred to includes figures deduced from the actual operation of the Diesel-electric system of traction in other countries, which indicate that its adoption in this country on the lines of the Weir report would cost only £150,000,000, as against about £340,000,000 for main line electrification. The return on the capital actually invested would be 15 per cent. for the oil-electric scheme, as against 6½ per cent. for the electrification scheme. Oil-electric trains could, it is pointed out, operate on lines where the traffic is not so dense as in suburban areas, and would give the same improvement in acceleration, cleanliness and increased availability which we now have come to associate with the electrified suburban lines. Oil-electric trains could also quite well operate economically in conjunction with steam locomotives. The fuel for the heavy-oil engines driving the generators could be obtained from British coal by the use of either the hydrogenation or the low-temperature carbonisation processes, while the saving in the amount of fuel required compared with steam locomotive traction would be, it is anticipated, well over £7,000,000. A further advantage of the oil-electric system would be the immediate availability of train units for service, with no waiting for the completion of an electrified section of the line. The possible danger that, owing to obsolescence, the adoption in, say, twenty years time, of improved systems of main line electrification would mean the loss of some of the original capital, would, it is suggested, be avoided, as new designs could be from time to time introduced as single units. A possible reduction in freight charges might be accorded in view of the 15 per cent. return on capital as compared with the 6½ per cent. for the electrification scheme, which is very little above ordinary dividend expectations.

The Late Mr. James Adamson.

IT is with great regret that we have to record the death of Mr. James Adamson, honorary secretary of the Institute of Marine Engineers, who was inseparably connected with the founding and the growth of the Institute from 1889 to the present day. Mr. Adamson died at his home at Harrow on Thursday last, following an operation, and many engineers were present at his funeral on Monday last at Pinner. He was eighty-one years of age, and up to the last took a very keen interest in all the affairs of the Institute. He came of seafaring stock, and was apprenticed in 1866 to a millwright in Falkirk, his birthplace, after which he spent four years with the engineering firm of Forrest and Barr, of Glasgow. In 1875 he came to London and entered the drawing-office of Messrs. J. and W. Dudgeon, of Millwall, afterwards spending some time at sea. On his return to this country he obtained a position with Alexander Stephen and Son, of Linthouse, and afterwards took a three years' course, at Glasgow University. In 1880 he was appointed an assistant to Mr. Malcolm Campbell, the superintendent engineer of the British India Steam Navigation Company, and on the death of Mr. Campbell in 1889 he succeeded him as superintendent engineer, remaining in that office until he retired after thirty-five years' of service in 1915. In the autumn of 1888, in association with several superintendent engineers at the Royal Albert Dock, he laid the foundation of the Institute of Marine Engineers, which has done so much for marine engineers and has now reached an honoured place in the ranks of our technical and scientific institutions. Mr. Adamson was the author of many articles, and he took a keen interest in the "Transactions" of the Institute of Marine Engineers, which have a world-wide circulation. He was one of the best-known personalities at the meetings of technical societies, and his death will be keenly felt by a wide circle of friends.

Improvements at King's Cross.

A SYSTEM of electric signals, which is being installed by the London and North-Eastern Railway at King's Cross, is nearing completion, and we understand that the first section of the work will be put into operation within a week or two. Up till now, a manual system has been in use. The scheme now being carried out involves the complete conversion of that system into an electrical one. In the new large signal-box in course of erection, 232 levers contained within an all-electric power interlocking frame, will be installed. The equipment of actual signals consists of sixty long-range colour lights and ninety short-range shunting lights, while route indicators are also included. About fifty freight trains pass through King's Cross daily, *en route* for the Southern Railway lines, while there is also heavy suburban and main line traffic. The new method of signalling is designed to facilitate this flow of traffic. The improvements are not, however, confined to the signalling apparatus. Increased accommodation for the large locomotives of the "Pacific" type, recently built by the company, is to be provided by enlarging the locomotive depôt. New equipment is also being installed, and this includes a mechanical coal-handling plant, a large turntable capable of carrying the largest locomotives, a new travelling crane, and a water storage tank with a capacity of about 70,000 gallons.

Costs in the Shipbuilding Industry.

No agreement was reached at the adjourned joint conference between the Shipbuilding Employers' Federation and the representatives of the shipyard trade unions at Carlisle on Thursday of last week. The conference, it may be recalled, was convened to consider the measures proposed by the employers for a reduction of labour costs in the industry. At the previous conference, held on July 23rd, already referred to in these columns, the meeting was adjourned for a final consideration of the position On Thursday, August 20th, small negotiating sub-committees were constituted, but they failed to bring about an agreement, although the employers intimated their willingness to allow more time to elapse before the reductions came into operation than was originally proposed. At the close of the conference, the employers gave an intimation that their proposed wages scheme would be applied in two instalments, the first in October and the second in January. The reductions proposed do not affect plain time-workers, except in a few special cases, where wages in excess of the agreed national time rate are being paid. In such cases any excess up to a maximum total reduction of 2s. 6d. per week will be removed in two instalments. To men on piecework and on other than plain time rates, the employers' proposals will involve the withdrawal of the time work bonus of 7s. per week, which also will be withdrawn in two instalments. In the case of riveting squads employed on piecework, a special scheme of consolidation and simplification of payment is to be introduced. The Shipbuilding Employers' Federation has no intention of closing its establishments in order to enforce acceptance of the wages proposed. It is significant, it points out, that during the last few weeks, since quotations have allowed for probable wage reductions and lower prices for materials, several orders for cargo ships have been placed in British yards.

The Schneider Trophy.

IN the very varied and broken weather of the last seven days, few opportunities for practice by the British High-speed Flight Team at Calshot were presented, but on several occasions various members of the team took the new Vickers Supermarine Rolls-Royce S 6 machines around the course, with eminently satisfactory performance results. The work on the construction of the orange yellow pylons at the turning points on the course, which is being carried out by the Admiralty, is now well advanced. Practice has again been started by both the French and the Italian teams, with, it is reported, good results; but as yet there is no definite announcement as to either the composition or the date of arrival of the French and the Italian teams, despite the arrival at Calshot of advance stores. The Air Ministry has now decided not to have the recently damaged Schneider Trophy seaplane rebuilt in time for the race, although the Supermarine works were prepared to guarantee its delivery. The intention is to postpone its rebuilding until after the race, and then to use it for future high-speed work. The seaplane which was earlier damaged and has been under repair for nearly six weeks, is now almost ready for service again.

The British Exhibitor.

THE "British Exhibitor," formerly the steamer "Leicestershire," of the Bibby Line, Ltd., which has been recently reconditioned and fitted out as an exhibition ship by Cammell Laird and Co., Ltd., of Birkenhead, arrived in the Thames on Tuesday last, and berthed in the Victoria Dock. On November 1st she is scheduled to begin her exhibition tour to the West Indies, North and South America, and Canada. The ports to be visited will include New Orleans, Havana, Kingston, Para, Rio de Janiero, Santos, Monte Video, Buenos Aires, Valparaiso, Callao, San Pedro, San Francisco, and Vancouver. The holds of the ship have been ingeniously transformed into spaces for exhibition stands, of which there is room for 500, with first-class accommodation for 230 persons. The exhibits already arranged for include examples of various branches of British engineering activity, including, of course, agricultural machinery, while modern methods of transport on the road, sea, and air will, we understand, not be neglected. The weather during the passage down the West Coast and up the English Channel was very varied, and it tested the sea-going qualities of the vessel, which was in a light condition. In spite of a gale, there was a marked absence of rolling and pitching, which promises well for the rigidity of the various trade exhibits which the ship has been specially designed to carry. Lord Auckland, who is the managing director of British National Exhibition Ship, Ltd., of Bush House, London, during the trip expressed a confident view of the success of the voyage.

Salving the P. and O. Liner Egypt.

ALMOST a year ago we recorded in these columns that the wreck of the P. and O. liner "Egypt" had been located off the coast of Brittany by the Italian salvage steamer "Artiglio I." The ship, which lies on an even keel at a depth of 66 fathoms, was, during the winter and spring, carefully marked by buoys, and in the course of the last few weeks marked progress has been made towards the recovery of the gold ingots which, it is believed, are stored in the bullion room situated in front of the forward funnel on the orlop deck. In order to reach this room it has been necessary to blast through four complete decks, namely, the boat deck, the hurricane deck, the upper deck, and the main deck. A few days ago a portion of the upper deck, some 30ft. in length and 50ft. across, was cut through by the explosive charges, and it has now collapsed on the main deck. Portions of the material so loosened have now been drawn to the surface, and when this *débris* has been lifted the top of the bullion room will be laid bare. The work has been impeded by the recent gales, and it is anticipated that three or four more working days will still be required before the main deck is bared. The work, which has been carried on at a depth of nearly 380ft. below the surface, is noteworthy in the history of deep sea salvage. If the weather continues to improve it seems not unlikely that the engineers of the "Artiglio II" will in a few days' time reach their desired objective.

Press-Tool and Fixture Design.

By HENRY C. LANE.

No. III.—BENDING TOOLS (*continued*).*

IV. Compound Action Bending (iii.).

In the two engravings, Figs. 15 and 16, is shown a pair of tools employing a rocker bending mechanism on rather a different principle. The rocker principle illustrated is not suitable for very heavy bending blows, but for light pressures it gives quite satisfactory results.

A blank, with one end curled, is shown at R in Fig. 15, and six bends are put in at one blow, as shown at R′ in Fig. 16. It will be seen that the bend at the curled end of the blank is a right angle, while that at the uncurled end is through something less than 45 deg. In the centre of the blank, four bends occur to form a crank of a depth equivalent to twice

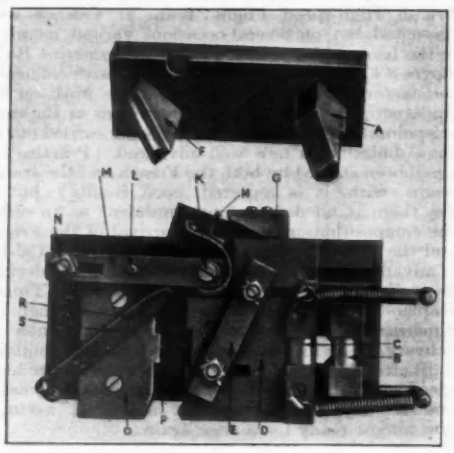


Fig. 15

the thickness of the metal, which is 12 s.w.g. (0·104in.). Originally, this pressing had a crank of a depth equal to the single thickness of the metal, and the metal was bent through something less than a right angle at the curled end. For this pattern we were able to bend complete in one operation without any compound action on the tools. Recently, the pattern was changed to that illustrated and pending the design and construction of satisfactory single operation tools we were compelled to obtain these six bends in two operations—one for the complete crank and one for the two end bends. The cranking operation was found to draw each end of the blank in by some $\frac{1}{16}$in. This shortening of the metal debarred us from bending the curled end at a right angle at the same instant that the crank was being formed, since the metal would have to stretch by that amount if it were possible, and, in any case, the bending points of the crank portion of the dies would be subject

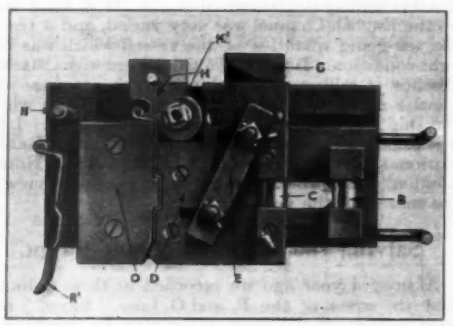


Fig. 16

to grave wear and continual replacements. Experience of bending the piece in two operations had shown us that the short crank of four bends, carried out on a plain "draw-bend" die, required very much more pressure than four times that required for a plain right-angle bend, and as, at the time the new tools were designed, I did not quite see how to produce the crank without utilising the draw-bend principle, if I was to finish the six bends in one blow, I decided that the draw-bend principle must be included, and provision made for increasing the effective pressure from the drive punch over and above that normally given by the direct ram pressure of the press. The production times for one gross parts finished were as follows:—Old pattern on old pattern single-operation bending tools, 35 minutes; new pattern bent in two operations, 45 minutes; new pattern on new design of tools, as illustrated, 18 minutes.

To obtain the necessary increased pressure for the cranking portion of the operation, the drive punch A in Fig. 15 was designed to give a ratio of press ram stroke to form slide D throw of two to one, which would, theoretically, and apart from frictional losses, give a pressure equivalent to twice that of the press ram. To withstand this pressure steadily, it was necessary to anchor the stationary form pad O very firmly to the die shoe. This was carried out by fitting two hardened and ground $\frac{1}{2}$in. square steel keys along the maximum length of the pad transverse to the line of thrust, suitable drive fit keyways being cut in the form pad and die shoe to accommodate the keys. The pad was prevented from lifting from the die shoe by suitable screws.

The form slide D is provided with two slots through which pass two pegs screwed into the base and carrying the retaining strap E under two locked nuts. This strap serves to prevent the slight lifting tendency of the slide when the punch A is withdrawn from the die and no additional slide retaining straps are necessary. The rocker H is hinged to the slide D and moves with the slide in the fixed relation shown in Fig. 15 until the parallel portion of the punch A has reached the roller C and its supporting roller B. As soon as the form slide has completed its stroke, the angle face of the rocker H is in perpendicular register with the punch F by which it is then engaged and forced inwards to complete the bend. Attention should be paid to the punch F, which, while being a simple angle drive, is provided with a radius driving face in order to present a satisfactory surface to the swinging driven face of the rocker. The rocker pivot pin K′—Fig. 16—is extended well above the surface of the die and has anchored to it on the clock-spring principle a flat coil spring, the outer end of which returns the rocker to position. Also, attached to the rocker pivot pin by means of the square end of the pin and a screw and washer K—Fig. 15—is the stripper carrier bar M travelling with the form slide D and guided by the peg N, which is fixed to the die shoe. From the stripper bar depends the actual stripping peg L, which extends downwards to the surface of the base plate and slides along close to the edge of the stationary form pad O.

Possibly, one point in the engraving of the tools in fully "up" position is misleading. It might appear that the support pad G for the rocker drive punch F also acts as a stop for the return of the rocker. Actually, this is not the case, a positive stop to the rocker being provided to prevent its swinging further back when it moves away from the support pad G with the stroke of the form slide D.

In operation the blank R is placed across the tools between form pad and slide, the curls facing the drive slide and lying loosely in a groove provided in the rocker. The blank is accurately positioned for bending by the gauge pin P on the form pad passing through the hole S in the blank. The form slide, driven by the punch A, draws the four bends forming the cranked portion in its stroke, and, in addition, puts the bend on the uncurled end of the blank. This extra bend on the one side of the tools might be expected to cause the slide to jam, and it is to overcome this tendency that the rocker is not allowed to swing entirely clear of the blank, a balancing bend being put in by the rocker bending face during this primary portion of the complete bending operation. On completion of this primary stroke, the rocker is in register with the punch F and is driven round by it to the position shown in Fig. 16, which also shows a bent blank in position after the down stroke of the press. As the punch rises, the rocker swings back under pressure from the coil spring, already referred to, and the slide D returning under spring tension and carrying with it the bar M brings the peg L into contact with the curled end of the blank and strips from the corner of the form pad, which is the only point at which the blank tends to hold tightly.

In closing, I would draw special attention to the design of the tools whereby a slight balancing bend does not prevent the metal from drawing in to form the cranked portion. The tools might be improved by incorporating a rocker mechanism for this cranking operation in order to lessen the pressure required for forming, but such tools would, of necessity, be much more complicated, and results, as far as the finished product is concerned, would not be correspondingly improved.

V. Compound Action Bending (iv.).

In most text books, compound bends of pressed blanks are shown as being carried out either in separate operations or in one operation, utilising a spring pressure punch to carry out the primary bend. With light sections of material, this method is quite satisfactory, but in heavier sections the spring punch method is not practicable on account of the tremendous proportions the spring would have to assume in order to carry out the necessary bending work to any degree of satisfaction, and, therefore, the designer must aim to get positive pressure in the required directions in order to surmount the difficulty. Furthermore, as I have already pointed out in Section I., it may be advisable to form each bend with as near as possible a true "bending" principle as distinct from a draw-bend, if breakages of the less ductile raw materials are to be reduced to a minimum. In the three sections immediately preceding, I have endeavoured to convey a principle that will enable designers to approximate the true "bending" principle when necessary, and the present section deals with the simpler principle of draw-bends in advanced design.

In the tools illustrated and described, the blank, as shown in Fig. 17, is taken from a soft, ductile steel of 0·05 to 0·15 per cent. carbon content. 2$\frac{1}{4}$in. long, 0·104in. thick. A roughly rectangular hole is pierced centrally across the blank, which is finally bent with six bends in one operation to the finished shape as shown in Fig. 18, so that the two holes in the ends of the blank come into register exactly opposite each other. If the ductility of the steel was

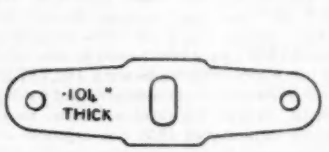


Fig. 17 Fig. 18

considerably less, the design of the tools would have to be drastically altered to remove the easy draw-bend principle involved in the present design.

Prior to the use of the tools as described, the bends were carried out at two operations, in a hand press, but the hole in the centre of the blank showed distinct signs of distortion and the production time with one operative was one gross in 60 minutes.

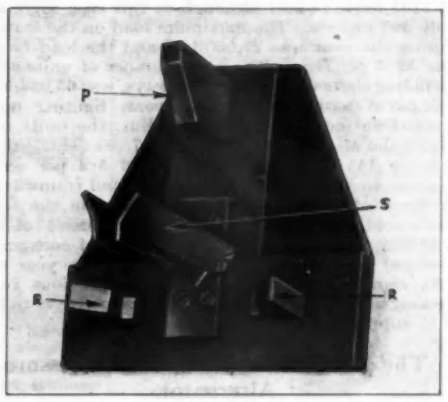


Fig. 19

With the new tools, no distortion of the hole takes place, and the production time for one operative on a power press has been reduced to 10 minutes per gross.

In the three reproductions are shown the punch pad from the under side—Fig. 19—the complete die in plan view—Fig. 20—and die with punch supports and die slide springs removed—Fig. 21.

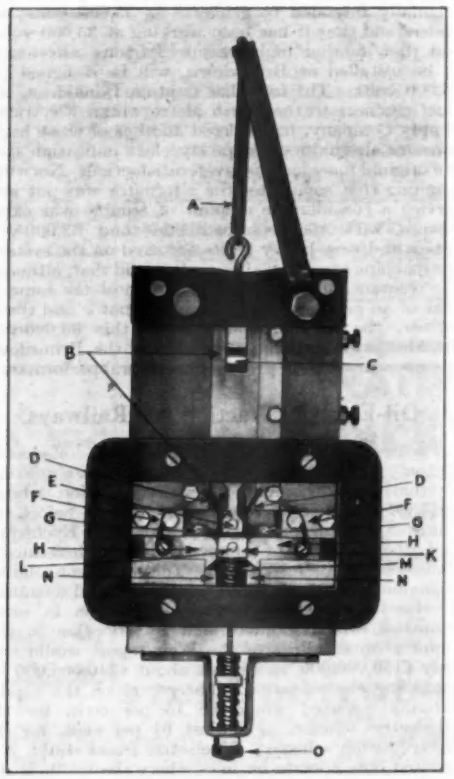


Fig. 20

As in previous sections, the view of the complete die is shown in the fully "up" position, while the stripped die is shown with all parts in the fully "down" position.

The construction of the tools required careful forethought, and the following points that had to be watched may prove of interest. Either the blank had to be bent around a stationary form punch

* No. II. appeared August 21st.

from which it might be difficult to strip, and by which method distortion of the hole was practically bound to occur, or the blank had to move with the form punch and return with the form punch to be stripped. This method was eventually decided upon as being the easiest of operation, and the specially shaped stripper legs S on the punch plate were provided, having feet, as illustrated, which operate on the two arms of the blank after bending has taken place. In addition, the distortion of the hole in the blank necessitated some suitable pressure pad, and this is shown at K in relation to the nose of the form punch B, and to which it is connected on its underside between the pins E and L, on which is carried a small hardened steel link allowing reduction of the gap between form punch and pressure pad, but preventing any increase over the pre-determined width. The small link has elongated holes for the pins to attain this object. The spring on the bar M, which is also attached to the pressure pad, only serves as a main spring return for the form punch, and the pad is prevented from motion beyond that allowed by the lock-nut O on the end of the bar M. Without the bar M the pad would not work in true relation to the form punch, the pressure from the bending blank tending to open the gap at the top, even though the connecting link prevented such opening from the bottom. The bar M acts as a support for the pad and successfully eliminates any such "hinging" tendency.

If the spring on the pad were the sole returning force for the form punch and pad, the blank would remain reasonably tightly held between punch and pad if the tools had been in use for any appreciable time, and to overcome this an auxiliary return spring A is fitted to the form punch to withdraw it a fraction farther than it is returned by the pressure pad,

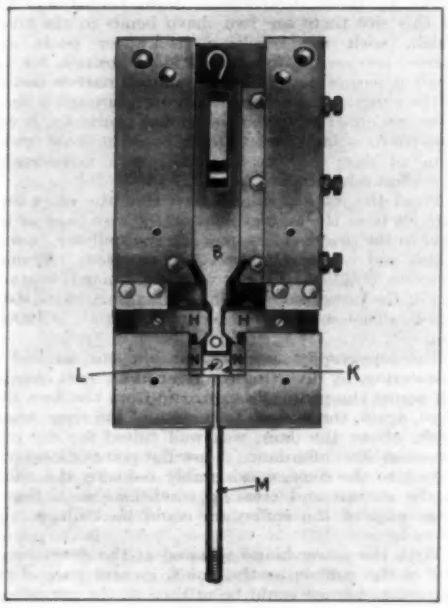


FIG. 21

and as far as the concealed connecting link will allow. This auxiliary spring return is by no means powerful, the main spring pressure being required to drive the bent blank from the first bend final dies N, which is accomplished by the main return spring already referred to.

The lengths of the operating punches and stripping legs were governed by the necessity of timing the slides; hence the top of the feet of the stripping legs are no lower than the upper surface of the form punch B when the press is fully up, and they are level with the lower surface of the form punch before the driving punch P for the form punch comes into contact with the roller C. Again, the plain 45 deg. angle driving punches R do not engage with the corresponding angle faces of the slides H until the parallel face of the punch P has reached the roller C; in other words, until the form punch B has completed its movement on the down stroke.

As far as the construction of the die goes, the main slide B and the two auxiliary slides H are of a plain dove-tail section, being held in position by the usual slide plates. The slide plates F of the auxiliary slides also act as end gauges for the blank when placed in position preparatory to bending, and the blank is held horizontal by the two pegs G, upon which the arms of the blank rest when placed edgeways in the gap between form punch and pressure pad. Two holes D are provided to accommodate the legs for stripping, as also is a hole provided in the die shoe to accommodate the main drive punch P. A slot—not seen in the figure—is provided to allow the connecting link between the form punch and pad to move with them. The first bend final dies N are driven into suitable holes in the base plate. A horizontal hole is provided just large enough to accommodate the bar M with the main return spring, and the square head of the pressure pad prevents passage of the pad through this hole. The form punch slide B has a slot, at one end of which is the roller C on which the drive punch P operates as it passes through the slot in the form punch and die shoe. The final bend slides H are, as will be seen, of an L-shape, the heel of the L being used as a primary bending die for the first bend, while the toe of the L, coming into contact with the die shoe, prevents the gap between the two slides being above a predetermined width. The bend in the blank resulting from these primary bending dies is a very easy radius, forming a right angle, and the secondary first bend dies N in conjunction with the final squeeze of the stroke of the form punch against the stopped pressure of the pad K produce a straight-sided and based U-shape bend, with sharp right-angle corners, after which the blank is firmly held for the final bends caused by the action of the slides H.

The sequence of operations is very simple. The blank is placed edgeways in the slot between form punch and pressure pad, and the descending drive punch P operating on the roller C forces form punch, blank and pressure pad, first, through the primary bending dies; secondly, through the secondary dies N; and finally, hard up against the die shoe, which acts as a stop for the pressure pad. The blank is then held by the pressure exerted from the parallel portion of the drive punch P, while the two final bending slides H are driven together by the angle faces of the drive punches R. The punch plate rises and the slides H are returned by the two small formed wire springs shown in the photograph of the complete die as operating on pegs in the slides. The main return spring M drives the pad, blank and form punch back as rapidly as the drive punch P will allow on its upward stroke, until further motion of the pad is stopped by the lock nut O, after which the form punch is withdrawn a fraction further by the auxiliary spring A. By the time the form punch has reached its final position, the feet of the stripping legs S are about to engage with the bent arms of the blank, which is then quietly lifted to the surface of the die ready for removal for the next operation.

(To be continued.)

Geophysics.

No. V. (*Conclusion*).*

SURVEYS BY THE SEISMIC METHOD.

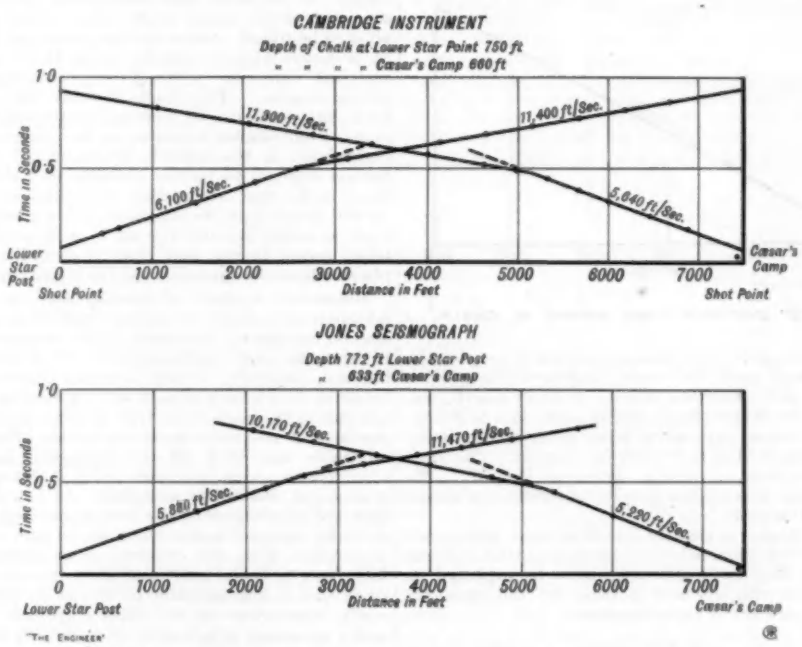
As an example of a survey carried out by the seismic method we give in the following an abstract of a report on a survey conducted at Chobham Ridges. Facilities were granted by the War Office for the carrying out of the work.

The investigations described in this article were conducted by the Geophysical Staff of the Anglo-Persian Oil Company under the auspices of the Geophysical Survey Research Committee of the Department of Scientific and Industrial Research. A number of areas which appeared to be suitable for the testing of the elastic wave method were suggested by members of the Geological Survey of Great Britain. The Chobham Ridges area was considered to offer the best facilities for the experiments, and Dr. Jones and Mr. Davies, of the Anglo-Persian staff, visited the district and satisfied themselves that the area was suitable for the tests. The purpose of the investigation was to test the elastic wave method by determining, if possible, the depth of the upper chalk under the cover of gravels, sand and clay. No definite information was available regarding the elastic wave velocities in the chalk and its overburden, but an appreciable difference in the velocities was expected. The survey party consisted of the following members of the staff of the Anglo-Persian Oil Company:—Dr. J. H. Jones, physicist; Mr. R. Davies, geologist; Mr. D. T. Jones, physicist; Mr. T. C. Richards, physicist; Mr. A. P. Hunter, surveyor. Mr. S. T. Newing, of the Department of Scientific and Industrial Research, was attached to the survey for some time.

Several instruments were available for the tests. The Cambridge Instrument Company kindly lent its new seismograph for the survey. This instrument was described fully in our last issue. Two instruments were provided by the Anglo-Persian Oil Company. One of these instruments was designed by Professor J. J. Dowling, of University College, Dublin. The other instrument supplied by the Anglo-Persian Oil Company was designed by Dr. J. H. Jones, and was described in our last issue.

Most of the records were taken with the Jones and Cambridge instruments, although a great deal of time was devoted to the Dowling seismograph. Two other seismographs of foreign manufacture were also available and were used on some occasions during the work. These instruments were far less sensitive than those mentioned above.

The party arrived at Bagshot towards the end of July and work was commenced early in August. After some preliminary testing of the various seismographs, a traverse was surveyed between Cæsar's Camp and Lower Star Post. On the completion of this traverse observations were made in the reverse direction, with the blasting point near Lower Star Post. The charges of gelignite used on these two traverses ranged from 1 lb. for the nearest shots to about 15 lb. for the further shots. The charge was usually buried at a depth of 3ft. to 4ft. The time of the explosion was recorded by means of a land line with a battery and vibration galvanometer in the circuit. At the instant of explosion this circuit was broken and the spot of light from the vibration galvanometer thrown off the photographic record. A field telephone was used for communication between the observation stations and the firing point, the firing being controlled from one of the observation stations. The times of arrival of the first impulses at the various stations have been calculated and plotted on the distance-time graphs—Figs. 35 and 36. The time-curves are shown separate for the two instruments. There are two widely different velocities shown on each graph. The first number of points lie on a line with a slope giving a velocity of 5220ft. per second with the Jones instrument—Cæsar's Camp to Lower Star Post—and a velocity of 5640ft. per second with the Cambridge instrument. In the reverse direction the velocities are 5880ft. per second with the Jones instrument and 6100ft. per second with the Cambridge instrument.



FIGS. 35 AND 36—DISTANCE-TIME GRAPHS, CHOBHAM RIDGES SURVEY

It will be observed that the velocity determined with the Cambridge instrument is higher in both cases by about the same amount. This difference can be caused by a slight error in the value given for the period of the time-marking pendulum in one of the recorders. The later points on the graphs lie on lines with slopes representing velocities between 10,170ft. per second and 11,470ft. per second. There is, therefore, a very definite change in the velocity and the discontinuity in the slopes of the time-curves is equally definite. This discontinuity represents a sudden change in the elastic properties of the rocks.

There are again slight differences in the value of the

* No. IV. appeared August 21st.

velocity through the second medium. The lowest value for this velocity was obtained with the Jones seismograph on the traverse from Cæsar's Camp to Lower Star Post. The velocity determined with the Jones seismograph in the reverse direction agrees better with the two values obtained with the Cambridge instrument. This small divergence may be due to the fact that different recorders were used with the Jones seismograph on the two traverses, and a slight error in the value of the period of the time-marking pendulum would be sufficient to account for the difference.

If the interface of the two media is horizontal, then the velocity through the second layer should be exactly the same in the two directions. If, however, the interface is inclined to the earth's surface, then the apparent velocity through the second layer will be greater than the true value if the elastic waves are travelling up the slope, and *vice versâ*.

To be exact, the apparent velocities U are given by the relation

$$U = V_2 \frac{\sin \theta}{\sin (\theta \pm \varphi)}$$

Where V_2 is the true velocity in the second layer, θ is given by $\sin \theta = V_1/V_2$ (V_1 being the true velocity in the upper layer), and φ represents the inclination of the interface to the horizontal.

The velocity in the direction Cæsar's Camp to Lower Star Post is slightly less than that in the other direction, so that we should expect the depth to be slightly greater at Lower Star Post. However, the difference in the velocity is very small, and as a first approximation we can assume the interface to be horizontal and apply the simple formula for the calculation of the depth.

It will be observed that the first line does not pass through the origin. This is probably due to the fact that the velocity varies rapidly near the surface over a shallow depth. We shall neglect this small error. This could be allowed for by taking observations very close to the shot point. In any case, it can only mean an error of 20ft. to 30ft. in our calculation.

The formula for the depth is :

$$h = \frac{L}{2} \sqrt{\frac{V_1 - V_2}{V_1 + V_2}}$$

where L is the distance of the discontinuity in the time-curve from the shot point, and V_1 and V_2 are the two velocities. The following figures for the depth of the second layer have been obtained with the two instruments :

(1) Cambridge Instrument Company's seismograph : Depth at Cæsar's Camp, 660ft.; depth at Lower Star Post, 750ft.

(2) Jones' seismograph : Depth at Cæsar's Camp, 633ft.; depth at Lower Star Post, 772ft.

In order to identify the second medium with the upper chalk, a short line was "shot" on the nearest

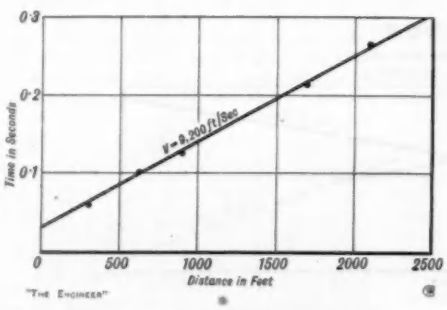


FIG. 37—DISTANCE-TIME GRAPH IN CHALK

chalk outcrops. The nearest exposures are on the Hogs Back, near the main Guildford–Portsmouth road. A short traverse, about ¾ mile in length, was surveyed on the north side of the road, close to Whitelane farmhouse, permission being given by the owner of the farm to blast in a chalk pit close by. The time-curve for this traverse is shown in Fig. 37. The slope of this line gives a velocity of 9200ft. per second through the chalk.

This velocity is slightly less than that determined at a depth of 700ft. below the surface on the Chobham Ridges. This small difference is to be expected on account of the gradual increase in the elasticity with the pressure of the overburden.

Conclusion.

Although the most important of the large number of present methods of geophysical surveying have been described and illustrated in this and previous issues, it still remains to discuss the relative uses and applications of the various methods and the place that they must take in physics and geology.

As it is very rapidly operated and the instruments can be handled without any special training, the magnetic method finds a place in the equipment for any kind of geophysical surveying. Although the places in which it can be used are limited to those in which materials with fairly well-pronounced magnetic properties exist, magnetic anomalies are associated with a large number of materials. Used alone, the results attained by this method are sometimes of doubtful value, largely owing to the fact that the magnetic properties of materials are not as completely understood as are the properties made use of in other methods. For instance, it appears that it is imperfectly known by how much the magnetic properties of a large body of otherwise homogeneous material can vary in its different parts. The method also suffers to a certain extent in very much developed areas from its great sensitivity, the effect, for instance, of a railway track being almost incalculable.

While the gravitational method is not so limited as to the nature of the materials by which it is affected, it suffers far more than any other from the influence of topographical features, and in hilly or mountainous country the uncertain terrain corrections that must be applied reduce its value almost to zero. It suffers also from the weight and the delicacy of the apparatus that must be used. The I.G.E.S. in Australia found that many of the torsion wires supplied for the instruments employed were faulty and frequent references are made to difficulties of transport. Very few observations can be taken each day owing to the lengthy interval that must elapse after each reading to allow the beam to settle. The method, however, has the advantage that its theory is complete and well understood, so that the interpretation of results is less open to doubt. Although it is of no use where stratified structures exist, and in spite of the fact that for large-scale work it is being rapidly displaced by the seismic, the method is particularly useful for the delimitation of comparatively small features such as coal beds, which are not susceptible to mapping by other methods. Owing to the fact that it can penetrate to greater depths, it has an advantage for this work over electrical surveys, when the deposits are too small to be properly mapped by the seismic method.

A variety of choice is offered by the electrical methods. The one used can be chosen to be suitable for the type of terrain occurring and the type of survey required. Although the majority of electrical methods are unaffected directly by topographical features, the effects of the geology of the district upon the readings obtained must be remembered if the best methods for the purpose in view are to be chosen. All types of electrical survey suffer from the disadvantage that the strength of the electrical indications falls off with disconcerting rapidity with increase of the depth explored, 500ft. being approximately the depth below which no indications can be regarded as reliable. The methods are suitable for detailed investigations rather than large-scale surveys. Although an electrical survey may fail completely in the presence of saline water where the soil resistivity becomes very low, fairly evenly distributed moisture is advantageous rather than the reverse. As its indications may be more definite and pronounced in promising areas, it is good practice to include a magnetic instrument in the equipment for an electrical survey.

The seismic method is well suited for large-scale survey and is particularly valuable where stratification exists. It has been used with great success for the discovery of salt domes in the neighbourhood of which oil is to be found. Since the salt transmits the waves at a much higher velocity than the surrounding material detection is frequently a comparatively simple matter. The Anglo-Persian Oil Company, Ltd., has made use of seismic instruments for some years, while similar instruments have been employed extensively in the oilfields of America. The penetration appears to be considerable, and claims have been made that structures at depths as great as 7500ft. have been investigated. The method, however, is hardly suitable for use in well-developed districts owing to the fact that it is difficult to find places where the explosive used will cause no damage.

Whatever method of geophysical surveying is adopted, some kind of ordinary surface survey must also be completed, although in the majority of cases it need be only rudimentary. With the torsion balance, however, a very accurate survey for the levels in the vicinity of each station must be made on account of the corrections that must be applied to the readings of the instrument for terrain effects. It is advisable also that all the geological information available should be obtained and that the opinions of a geologist should be available. It is very seldom that the predictions of the instruments can be unreservedly accepted unless they are, in part at least, in accordance with the conclusions of geologists. In fact, geophysicists and geologists must co-operate, since each is indispensable to the other, while neither really encroaches on the other's ground. What is really necessary is a supply of men with a sufficient knowledge of both subjects to combine the two *rôles*.

In conclusion, we would point out that, at present, geophysics is only at the beginning of its development. Instrumental improvements and research into the properties of materials *in situ* combined with the collection of knowledge and the acquisition of experience are bound to bring about an increase in the exactitude of the science and a greater understanding of the results obtained by surveying.

Finally, we desire to acknowledge here, with many thanks, the help and information we have received in compiling these articles from Captain Shaw, of the Science Museum, South Kensington; Professor Rankine, who has recently been elected to the Chair of Geophysics at the Imperial College of Science and Technology; Mr. Broughton Edge, the Director of the Imperial Geophysical Survey, and many others. We also desire to record the fact that the results of the magnetic survey over Swynnerton Dyke, given in Figs. 7 and 8, and the results of a seismic survey, Fig. 28, are reproduced from the *Mining Magazine*. The Anglo-Persian Oil Company, Ltd., put at our disposal the report upon the seismic survey at Chobham Ridges, included in this issue, and a number of manufacturers provided us with information regarding their instruments.

The Alexander Power Development Scheme.

The Alexander hydro-electric system, which came into service in October, 1930, is the second constructed on the Nipigon River by the Hydro-Electric Power Commission of Ontario. It has a capacity of 54,000 H.P., and, with the existing plant at Cameron Falls, supplies the cities of Fort William and Port Arthur, about 80 miles distant.

In 1926 the Commission built a control dam at Virgin Falls at the outlet of Lake Nipigon, creating thereby the largest storage reservoir in existence, having a capacity of 6,700,000 acre-feet, which was of considerable use in closing the river to all flow when the time came to make the final closure at the Alexander development.

The growth of load on the system and the prospective load, following the completion of the Cameron Falls plant, made it necessary for the Commission to proceed with plans for additional generating capacity. A study of the sites available indicated the advisability of choosing the site at Alexander Landing, about 1½ miles downstream from Cameron Falls. At this site there are two sharp bends in the river, which, with the resulting backwater pools and narrow peninsulas, formed an ideal position for the development of power. By damming a narrow section of the river and diverting the water through a short diversion canal across the adjoining peninsula, it was possible to isolate the two main constructional operations of dam and power-house, with considerable attendant advantages.

From the map it will be seen that the main dam extends from the high ground on the east bank of the river to the peninsula upon which the spillway, power-house and other structures are situated. A short concrete bulkhead section unites the north-westerly end of the power-house with the auxiliary earth dam, which, although never more than 23ft. high, is 1800ft. long.

The topography suggested an efficient method of dewatering, by diverting the river in an open channel cut across the peninsula upstream from the dam site. Here, again, the natural formation of the river, about 600ft. above the dam, was well suited for the construction of a cofferdam. A low flat point of land projects into the river, considerably reducing the width of the stream and creating conditions such that a large part of the cofferdam could be built on dry ground.

With the power-house situated at the downstream end of the cut across the point, greater part of the diversion channel could be utilised as the permanent feeder for the development. The dewatering channel proper as it nears the head works is diverted away from the feeder canal to the east, and passes through the line of the spillwall in a narrow rock cut. The closure works were built here, and the concrete for this structure ultimately formed the base for that section of the spillwall.

Where the river was diverted through the spillwall, two water passages were built, each 18ft. wide and 27ft. high, giving ample area with the water at the cofferdam safely below the top to take care of any reasonable contingency in river flow. For closure, each of these areas was provided with checks to receive steel gates in three sections, each 10ft. 4in. high.

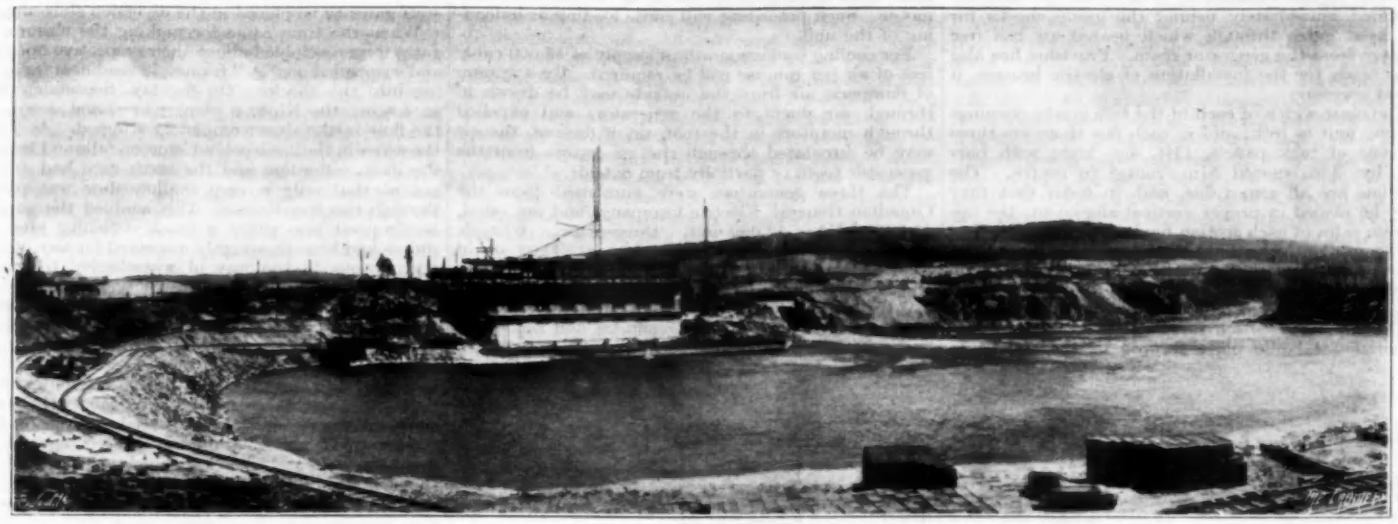
Main Dam.

The most suitable site for the main dam was at a point on the river about 1½ miles below the Nipigon development, where the flow passed in a narrow channel flanked by rock on either side.

The presence of suitable and abundant materials for earth fill at elevations well above the top of the dam on the east side of the river indicated that the probable unit cost for an earth dam would be relatively less than usual, and this, with other considerations, proved the deciding factor in the choice for this form of dam.

Soil-bearing tests made at a number of points on the proposed site indicated that the bearing value of the soil was well within the margin of safe practice. The rock walls at the shore ends of the dam were of a naturally rough formation, which, when cleared of all loose and weathered matter, revealed a vertically serrated surface providing a suitable seal for the core and abutments. Before any earth fill was placed, heavy rock dump was made, forming the toe for the downstream side. This material was excavated from the rock section of the diversion channel and power-house substructure. The section chosen had a crest width of 20ft. with downstream slopes of 2·5 to 1 and 2 to 1, and upstream slopes 3 to 1 and 5 to 1.

THE ALEXANDER POWER DEVELOPMENT, ONTARIO



DOWNSTREAM SIDE OF POWER HOUSE

UPSTREAM SIDE OF POWER HOUSE — POWER HOUSE COMPLETED

Its maximum height as built is about 90ft. As the base of the dam is below tail water level, extra precautions were taken to protect the toes of the slopes.

The section as built is much larger than designed, as a consequence largely of the necessity of keeping dump tracks safely back from the edge of the segregation pool to prevent sliding. The total yardage of the dam proper, exclusive of clay blanket upstream, is about 530,000 cubic yards, and from the time the season opened in May up to the end of August there were 443,000 cubic yards placed in the dam.

The dam was built by the "semi-hydraulic" process, the materials being taken from selected borrow pits on the east side of the river. Some of the borrow pits are in gravel and sand, while others are in pure clay, so that any mix determined to be desirable could be had by regulating the amount taken from each of the pits.

The spillwall, in its final position, is 523ft. between abutments, and varies in height from 1ft. to 18ft., with an average of 7ft. These heights do not include the depth of section where the diversion channel sluiceways pass through. The crest level provides for a maximum discharge head of 6ft., and, according to Bazin's formula for flow over a sharp-crested weir, as modified for this shape and depth, the discharge capacity is 30,000 cubic feet per second.

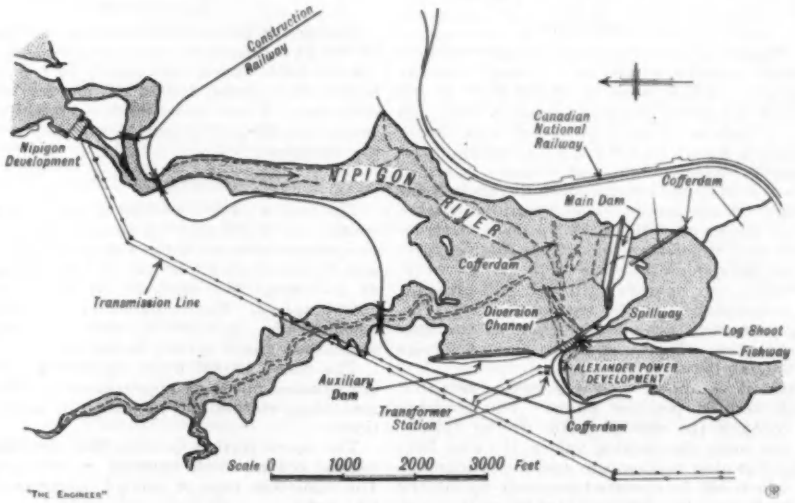
At the junction of concrete and earth sections for both auxiliary and main dams, specially designed abutments are built in a similar manner to that for a bridge abutment sustaining an earth fill approach. The arrangement provided maintains at all times a tight contact between the earth and concrete.

The auxiliary dam, running west from the power-house, was made up of a concrete section tied into an earth dyke. The concrete bulkhead portion of this dam is the conventional type, having a 3ft. top width, a batter of 8 : 12 on the downstream side, and a maximum height of 25ft.

The Power Canal.

This channel, in rock, is 50ft. in width and about 33ft. deep. The course is straight for about 500ft., and then deflected to the left through 19 deg. toward the temporary sluiceways used during construction. Downstream from the point at which the course of the diversion channel deflects, and to the right of the channel, the earth overburden was removed to form a forebay. This, and a small amount of rock excavation immediately in front of the headworks, constituted the only additional excavation required for the power canal that was not removed for the diversion channel.

To the left of the power canal, excavation was carried down over the whole of the remaining area to elevation 660, in order to assure free access of flood-water to the whole of the spillway crest, which is at elevation 667·25. To the right of the canal the original surface is practically all submerged up to the auxiliary dam, so that, under operating conditions, there appears a large head pond having an extreme width of over half a mile, completely submerging the original channels of the Nipigon River, Fraser Creek, and the diversion canal.



SITE OF MAIN DAM AND POWER HOUSE

Headworks.

Usually, in the design of headworks for a power development in a northern latitude, it has been considered necessary, and until recent years has become customary, to provide a superstructure with travelling crane for handling stop logs, racks, and head gates. In order to eliminate as far as possible this added expense, it was decided to design the head works without a superstructure. However, in consequence of the extremes of low temperature and heavy snow-falls prevailing during the long winter periods, certain protective measures had to be incorporated to guard against formation of ice in the rack and gate checks, and to protect the head-gate hoisting mechanism. Some of these arrangements can be seen in the sectional drawing of the power-house.

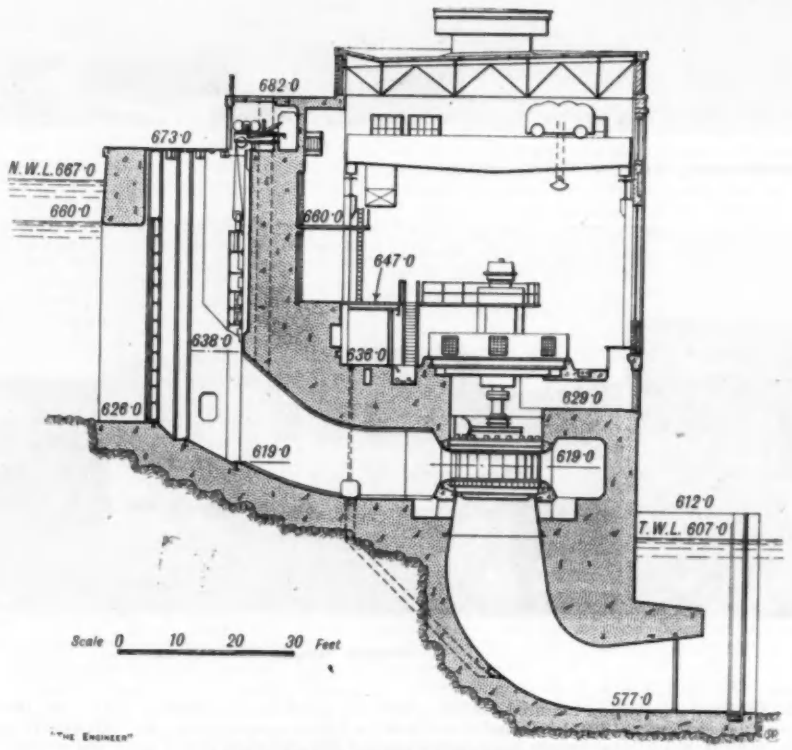
To raise and lower the head gates during normal operation, there are provided motors and hoists enclosed in a low-roofed passageway, about 7ft. high, running parallel with the centre line of the units. Each unit has two gates operated by one motor through disengaging clutches on the main line shaft. The placing and removal of stop logs, racks, and head gates is done by a locomotive crane operating on a standard gauge track on the head works deck. The locomotive crane may be used, not only for this purpose, but for innumerable other operations.

All openings over the stop log and rack checks have

matched plank covers made in sections fitted for quick handling; so that with concrete curtain walls extending below low head water level for each intake, the guide checks are well protected. In addition to this measure of protection, openings are provided immediately behind the guide checks for the head gates through which heated air has free passage from the generator room. Provision has also been made for the installation of electric heaters, if found necessary.

The clear width of each of the two intake openings for one unit is 18ft., and in each one there are three sections of rack panels, 11ft. 8in. high, with bars 3in. by $\frac{1}{8}$in. spaced $5\frac{7}{8}$in. centre to centre. The sections are all removable, and, in order that they may be placed in proper vertical alignment, the upstream sides of each section have oak guides fastened full length to the vertical side members of the frame, which ride against the upstream side of the guide check. The total width of I-beam and oak guide is 1in. less than the width of the guide check.

The top rack section for each intake opening has a horizontal baffle plate secured to the top beam of the frame and extending upstream nearly to the curtain wall to prevent floating material from passing over the top of the rack, which is below headwater level. The rack sections are designed for a differential head of 10ft., to allow for the accumulation of ice or *débris*.



CROSS SECTION OF POWER HOUSE

Hydraulic Equipment.

The hydraulic equipment consists of three vertical shaft Francis turbines, placed in reinforced concrete scroll casings. Each is rated at 18,000 H.P. at 100 r.p.m. under a normal operating head of 60ft. In general, the turbine consists of a cast iron runner wheel weighing about 95,000 lb., with fifteen blades cast integrally between hub and crown. A set of twenty cast steel gates are installed to regulate the flow of water. These gates are cast integrally with the gate stems, which are connected by links and pins to the cast steel regulating ring. This ring, in turn, is connected through adjustable rods to the two servomotors, which are operated through oil pressure. The link connection is of the tension-shearing type, providing protection against distortion of the gate shaft or breaking of gate arms in case of foreign material lodging between the gates.

Each unit is equipped with a governor actuator, sump tank and oil pressure pump. The governor actuator contains the electric motor driven flyballs, the pilot and main distributing valves, the gate limit device, the restoring mechanism, and the synchronising gear, which can be operated remotely by electric motor or by hand. The actuator is of the well-known Woodward type. Each unit is controlled by a single hand wheel.

As a novel feature for synchronising, an automatic speed matcher is furnished. It consists of two special three-phase electric motors, one of which is connected to the unit which is to be synchronised, the other to the bus. These two motors rotate in opposite directions and are directly connected to a differential gear, which is placed on the synchronising gear shaft, which, in turn, lowers or raises the pilot valve stem, thus opening or closing the turbine gates, as required. When the frequency of the unit and bus is alike, both motors will be operating at the same speed, and the shaft of the differential mechanism will stand still, under which condition the circuit breaker can be closed. While the oncoming machine is connected to the power system, it is at any time possible either to raise or lower the gate by operating the bus-connected motor. Such procedure will cause loading or unloading of the unit.

For cooling each generator a supply of 55,000 cubic feet of air per minute will be required. By a system of dampers, air from the outside may be drawn in through air ducts to the generators and expelled through monitors in the roof, or, if desired, the air may be circulated through the generators from the generator room or partially from outside.

The three generators were purchased from the Canadian General Electric Company, and are rated, 15,000 kVA, 12,000-volt, three-phase, 60-cycle 100 r.p.m., 85 per cent. power factor. They are of welded structural steel design, only the guide bearings and bearing houses being cast.

A three-phase tap has been taken from the armature of the pilot exciter of each generator and run direct to supply the governor fly-ball motor. This eliminates the necessity for step-down potential transformers and connections to supply the flyball motors and supplies a potential direct to them as soon as the generator is rotated, whether the 12 kV connections are connected to the generator or not.

Transformers.

The power transformers consist of three outdoor, 15,000 kVA, radiator type, oil-insulated, self-cooled (22,500 kVA forced air-cooled), 80 per cent. power factor, three-phase, 110/12 kV, 60-cycle, 55 deg. rise, with four 5 per cent. high-voltage full capacity taps above 63·5 kV, connected to manually operated tap changers.

Electrical Layout.

The entire 12 kV switching and bus connections consist of metal-clad equipment of latest design, so constructed as to fit the various bays in the station and to form a ring bus system. The capacity of the 12 kV main bus and all oil circuit breakers is 2000 ampères. The breakers are all electrically and mechanically interlocked with the disconnecting switches to guard against faulty operation.

The three 15,000 kVA, three-phase transformers are situated outdoors approximately 250ft. from the generating station and mounted on concrete foundations.

The entire station is controlled electrically from a central control desk situated in the control room. The miniature type of control equipment is used on this desk.

Closure of Diversion Channel.

Construction work proceeded rapidly in all sections of the development throughout the summer of 1930. By the third week in September, the fill in the main dam was brought to elevation 681 throughout its length, the head gates were in place in front of each of the turbines, and a week later the gap in the auxiliary dam, through which the construction railway had passed, was closed, and No. 3 generator was completed. By this time also, arrangements had been made for closing the outlets of the diversion channel and raising the headpond to operating level.

For several days before the closure, the headpond levels at the Nipigon station were regulated to meet the period of shutdown without wasting into the Alexander reach and to allow ample time to draw down the Alexander headwater pool to permit the steel gates to be placed in the diversion sluiceways.

When the time came for making the closure, the gates were assembled above their respective openings, and suspended on "A" frames, in readiness for lowering into the checks. On Sunday, September 28th, at 4 a.m., the Nipigon plant was closed down, and the flow in the river completely stopped. At 7 a.m. the water in the river below Cameron falls and between the main cofferdam and the earth dam had drained out so that only a very shallow flow was passing through the two sluices. This enabled the gates to be dropped into place without difficulty after the sluices had been thoroughly inspected for any possible obstructions in the way of waterlogged timbers or gravel. Practically no obstructions were found, and the gates were dropped into place and sealed. At 10.25 a.m. the entire closure had been completed.

Early the following morning water began to flow over the spillwall, and by evening was passing over to a depth of more than 3ft. With a few minor exceptions, the structures proved to be entirely watertight. A very small leakage through the closure gates was stopped up by dumping cinders against the upstream side and allowing them to be carried into the openings by the current.

All the work in connection with the development was handled by the Commission's staff, of which F. A. Gaby, M.E.I.C., is chief engineer. Construction of the plant was carried out by the Commission's Construction Department, of which A. V. Trimble, M.E.I.C., is head. The design of all structures, except the power-house superstructure, and the general supervision of construction was in charge of T. H. Hogg, D.Eng., C.E., M.E.I.C., chief hydraulic engineer, assisted by Otto Holden, A.M.E.I.C., assistant hydraulic engineer. The power-house superstructure and all electrical design was handled by the Electrical Department, under E. T. J. Brandon, A.M.E.I.C., chief electrical engineer. W. S. Lee, M.E.I.C., of New York, was consulting engineer on the design and construction of the earth fill dam.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOW-TEMPERATURE CARBONISATION.

SIR,—The article by Mr. J. B. C. Kershaw in your issue of August 7th, reviewing the position of low-temperature carbonisation companies at this date, paints a gloomy picture, as is probably intended; but it is, possibly, not any gloomier than the picture that could be painted of many of our formerly successful industries at this time. We are in a period of depression, and any industry which has to establish itself in these times has not its troubles to seek. I am fully convinced that low-temperature carbonisation will overcome its troubles. If working under similar conditions, it would be very difficult to get a satisfactory balance sheet from any high-temperature carbonisation process to-day.

The production of oil in this country is a vital necessity, yet our shale industry is being closed down, even with an advantage of 6d. per gallon on home-produced petrol in its favour. A large number of coke ovens are shut down owing to the diminished demand for metallurgical coke, and the exceptionally low prices for tar and ammonia. Many more are carrying on at a loss or existing only by reason of the fact that they are obtaining small coal for carbonising at an uneconomic price. The gas industry, almost entirely a high-temperature industry, continues only because it can command a monopoly price for one of its products, viz., gas. The low-temperature processes have to establish themselves under a heavy handicap.

With coke ovens shut down it is unlikely that colliery owners will be anxious to start on the production of a low-temperature coke, even though it has superior qualities. The attitude of the gas industry to the Yorkshire gas grid scheme has indicated the stranglehold the gas industry intends to keep on any outside supplier of gas. A fraction over a penny per therm is a ridiculously low price to offer for a quality of gas that is costing them nearly three times this figure to manufacture. There are very few gasworks in the Kingdom which could pay their way to-day if they received a figure under 3d. per therm for their gas into holder.

These observations are by the way. The main purpose of this letter is to deal with the process which bears my name and which has been in operation at Glasgow now for six years and at Nuneaton for three years. Mr. Kershaw gives the revenue account of the smokeless fuel plant in Glasgow for 1930, which shows a loss, and explains this loss as due to the disadvantages of an internally heated process. This is an issue on which I must disagree. In the first place, any account giving such meagre details as the Corporation smokeless fuel plant revenue account gives, has to be examined with some knowledge of the details. Taking the accounts for 1931, we find a loss of £2729, after charging 4s. 3d. per ton for interest and sinking fund, and 1s. 6d. per ton for rates and taxes. Even so, had the gas made been credited at 2½d., or 0·5d. more per therm, the plant would have

met all the charges placed against it. Now, the cost of gas made by the ordinary high-temperature gasworks processes in the same year's accounts is found to be practically 3d. per therm, before interest and sinking fund and rates and taxes are charged.

The gas from the Maclaurin plant on the same basis costs 1·7d. The disadvantage of an internally heated plant, therefore, can only hold if a 475 B.Th.U. gas is intrinsically of more value at 3d. than a 240 B.Th.U. gas at 1·7d. My belief is that no such difference in value exists after allowing for the actual difference in distribution costs. The truth on this point I am urging should be determined experimentally on a practical scale.

The recovery of the ammonia in the Maclaurin process is not impracticable as stated by Mr. Kershaw, and though the light spirit passes on with the gas it is not lost. The total quantity passing, however, is only 1¼ gallons per ton of coal, and even if we value this at 5d. per gallon, if the gas is valued at 2·5d. per therm, there is no financial loss.

Returning, however, to the revenue account, there are a number of other points to be considered. In the first place, it is unusual for any plant which is being worked under 45 per cent. of its rated capacity and about 35 per cent. of its actual capacity, to meet its interest and sinking fund charges. The Dalmarnock plant has seldom been worked to 45 per cent. of it's capacity. Rates, taxes and interest charges, therefore, have to be borne by less than half the possible throughput. In addition, the wages become excessive. A fair comparison, however, can be made between high-temperature externally heated processes and the internally heated low-temperature Maclaurin process by adopting the usual gaswork method of finding the cost of coal for gas-making after deducting residuals. This, as calculated from the Glasgow Corporation gas accounts for 1931, is as under :

	Glasgow high-temperature processes. 1930–31.	Maclaurin low-temperature processes. 1930–31.
	s. d.	s. d.
Coal, per ton	17 5	18 5
Less coke, tar and ammonia	7 3	13 8
	10 2	4 9
Fuel cost of gas	1·54d.	0·7d.

As the number of therms under high-temperature conditions was 79 and in the Maclaurin plant was 81, we get a fuel cost for gas of 1·54d. from the high-temperature processes, and 0·70d. for the Maclaurin plant. An addition has to be made for wages, repairs, rates, taxes, depreciation and interest to arrive at the actual cost per therm.

Mr. Kershaw acknowledges that in a plant of the Maclaurin type these charges will all be lower, provided the plants are operated at the same percentage of their capacity. The low throughput in the Maclaurin plant is, therefore, the principal cause of the loss shown in the revenue accounts at Glasgow. It is a pity that the cost figures for Nuneaton were not in Mr. Kershaw's possession. This plant has some improvements on the Dalmarnock plant, which it has to be remembered was erected six years ago, and is still working without any radical change. The Dalmarnock plant was erected when prices were relatively high at a total outlay including railway sidings, and buildings, of £47,000, whereas to-day a better plant could be erected for £36,000.

Unlike the Glasgow plant, the Nuneaton plant has made a profit for the shareholders from the beginning, paying 7½ per cent. on its preference and 5 per cent. on its ordinary shares for 1929. The working costs to October, 1930, while the plant was under the control of the Maclaurin Fuel Oil and Gas Company, were almost the same as in 1929, while the gas yields and oil yields were rather better. The price of oil was, however, less. The maintenance, repairs and general charges from the start until the plant was taken over by the Nuneaton Gas Company have not amounted to £50 per annum.

Beneath is given a copy of the 1929 balance sheet for Nuneaton, which has been audited and certified as correct by Mr. A. D. McDougall, C.A., of Glasgow :

Revenue Account for Year Ended December 31st, 1929.

Revenue.

	£	s.	d.
By gas sales, 391,536 therms at 2¼d. ..	4078	10	0
„ Oil made during 1929 and sold, 63,384 gallons at 3·57d. per gallon, less carriage	895	9	10
„ Oil made during 1929 and added to stock, 22,555 gallons at 3d. per gallon	281	18	9
„ Coke made during 1929 and sold, less carriage	1005	14	1
„ Coke added to stock	332	10	0
	£6594	2	8

Expenditure.

	£	s.	d.
To coal purchased and carbonised during 1929, 4024 tons at 18s. 6d., including carriage	3730	2	11
„ Wages and insurance	740	8	8
„ Supervision	350	0	0
„ Electricity, gas and steam	185	7	8
„ Maintenance, repairs and general charges	47	8	6
„ Depreciation at 7½ per cent. on £7500	562	10	0
„ Balance, profit on working for year ..	978	4	11
	£6594	2	8

Glasgow, August 18th. ROBERT MACLAURIN.

RESEARCH IN INDUSTRY.

SIR,—The paper by Dr. Axel Enstrom, printed in THE ENGINEER of June 5th and liberally endorsed in your editorial columns, contains many points worthy of continuous attention.

The frequent references to research in the current Press, scientific, technical, and popular, justify a more precise terminology, such as Dr. Enstrom suggests, but I fear that the terms selected may not succeed in dissipating the prevailing confusion. A great part of scientific research is predominently systematic, and technical research is much indebted to spontaneous contributions. A still more precise analysis is of importance, not merely as a matter of consistent nomenclature, but as a basis for more systematic and successful achievement in research.

Without venturing to advocate specific terms, I would prefer to emphasise the distinction between "research for supply" and "research on demand." The increasing appreciation of pure research by industrialists is due to an appreciation of the fact that many of the successful applications of science to industry have neither been "made to order," nor have they been the results of fortunate accidents. Rather they have resulted from drafts upon the accumulated stores of pure scientific knowledge, amassed partly by plan and partly by accident, but largely without reference to immediately useful applications. The policies of the most far-sighted industrialists include the duty of keeping these stores replenished, in order that ample resources may be available when the demand arises for a determined attack upon a specific problem. "Research for supply" might also be termed "inductive research," and "research on demand," "deductive research." As in mathematical problems, the flexible use of the integral calculus always presupposes the results of considerable activity in the use of the differential calculus, so in industrial problems the most fruitful employment of "research on demand" for the solution of specific problems will always presuppose previous activities in the field of research for the supply of novel and interesting knowledge, spontaneously accumulated, independent of immediate demand.

Those experienced in the application of research to industry have testified that financial investment in research may, on the average, require a much longer period to show returns than any of the more familiar forms of capital investment. It follows that even greater care and foresight are required in laying out research projects in advance, and in making adequate provision for the accumulation of reserves of hitherto unapplied knowledge.

Until recently, this gold reserve of pure science in research has been furnished chiefly as a by-product of the educational system—by universities, colleges, and private investigators. Modern industry is beginning to realise that, on the scale in which it operates, more systematic and ample provision must be made for maintaining the gold reserve.

One of the most effective means for securing the general adoption of this sound policy is found in the prevalent use of terms which remind everyone, at least by implication, of the essential factors in the situation.

In dealing with a bank, cashing large cheques is a much more attractive process than that of building up a solid bank balance, yet it is quite generally accepted that the former process is not feasible unless adequate attention, however reluctant, has already been given to the matter of accumulating the necessary positive balance.

CAMPBELL MACMILLAN,
Induction Motor Department.
General Electric Company, Schenectady, N.Y.,
August 14th.

THE EFFICIENCY OF "KEARSLEY."

SIR,—I note that in your answer to the letter by R. H. Dill on the above, in your issue of August 21st, you state : "With regard to the influence of load factor, the Parsons line shows that, within the limits of commercial accuracy, the total fuel consumption of any power station over a given period of time is a linear function of the electrical output during that period. Hence, to every output, there corresponds a definite fuel consumption, independently of whether the load was regular or not during the period."

One cannot but agree with this opinion, and yet, for any station designed for, and carrying, a certain maximum load, the consumption per unit will be reduced as the load factor is increased, due to the fact that the no-load consumpt becomes a smaller proportion of the total as the output increases.

It may be argued that the load factor may increase and yet the output be reduced, but in that case I question if the original Parsons line would still hold.

W. Ross,
Power Station Superintendent,
Electricity Department, Glasgow.
Glasgow, August 24th.

TRACING PAPER.

SIR,—Every engineering drawing-office uses tracing paper and has to buy it in fair quantities.

When we buy tracing paper, what decides us in selecting a paper on looking through a salesman's sample book is (1) its transparency, (2) its stoutness or strength combined with its being non-brittle.

On the other hand, experience tells us that any paper having a smell or a greasy, shiny surface will, after about two or three years in a drawer, turn green and fall to pieces in the hand, whereas the non-shiny paper will last for years as good as when first bought ; the reason being that the shiny paper is manufactured opaque and then run through a bath of oil or grease to make it transparent, while the other paper is pulped so fine during manufacture that on being rolled into a sheet it is transparent without being oiled. Or, in other words, one is a mixture of grease and paper which undergoes chemical change with time, while the other is a pure paper practically everlasting.

Further, we find that all the pure paper samples come from Germany or Belgium, while the British manufactured tracing paper is of the greased variety. The small number of British pure paper samples shown—usually only one—is so opaque that a draughtsman would need X-ray eyes to see through it. It is therefore to be inferred that the British paper manufacturer is losing trade to the German tracing paper manufacturer, because he will not pulp his paper fine enough for it to be transparent without oiling. Is this not a deplorable state of affairs ? Or does it mean that no British engineer ever stores his drawing or tracing paper away in a drawer ? And hence never undergoes the experience of his drawing turning yellow and falling to pieces in his hands.

I do not think that this conclusion is accurate.

THOS. H. WEBSTER, A.M. Inst. C.E.
London, August 20th.

THE COMMERCIAL FALLACY OF "DIESEL-ELECTRIC" RAILWAY TRACTION.

SIR,—The amount of publicity which is at the present time being given to the "Diesel-electric" traction system would at first sight make it appear to the uninitiated that this now quite old-fashioned system is the real solution to the railway traction problem. As one of the earliest constructors of this type of traction I am sure that the results anticipated will not be fulfilled, chiefly because of the high initial cost and also the low average draw-bar efficiency obtained. In addition to the high cost per horse-power, which, together with the electrical equipment, runs into approximately £15 to £20 per horse-power, there is the fact that no regeneration can take place, as there is no provision for the reception of the regenerated current. The consequence is that extra powerful oil engines have to be employed, in order to meet the heavy demand for power during the short periods only, while acceleration and grade climbing is taking place. For the rest of the time the large engine is running unloaded, and consequently inefficiently, and particularly when descending gradients, when negative work has to be done and fuel spent in pumping up braking air supply.

May I suggest that the time has now arrived for a proper investigation into the present inefficiency of the steam locomotive and with a view of improving the heat cycle and thus making it thoroughly capable of meeting the demands of modern railway traction ? This can be done and, in fact, has been done. There is no other transportation apparatus which is or can be so efficient as a "heat" engine. All other methods are simply makeshifts and cannot stand the commercial competition of the "heat engine" properly designed and applied. WILLIAM P. DURTNALL.

London, S.E. 5, August 19th.

SIXTY YEARS AGO.

TRADE was prospering in September, 1871. In our issue for the first of that month our correspondents in the provinces were unanimous in reporting full order books, good prices and all-round activity. On Birmingham Exchange finished iron had been advanced 10s. per ton within a fortnight, and there was talk of doubling that rise. Additional blast-furnaces were being blown in as rapidly as they could be prepared for work. Puddlers' wages were to be advanced 6d. per ton and the coal and ironstone miners were also to receive increases. Tin-plate consumers could only get prompt supplies on makers' terms. At Cleveland there was an eager inquiry for pig iron for immediate delivery, but the makers could not accept the orders that were being tendered to them. Many new furnaces were being constructed, but it was estimated that three or four years would elapse before the supply overtook the demand then existing. Shipbuilders on the Tyne, Wear and Tees were exceedingly busy, and engineers were finding it difficult to finish their work sufficiently quickly to satisfy their customers. From Glasgow it was reported that the Scottish coal trade was everywhere brisk, that new fields were being opened up and that at existing mines shafts were being deepened to tap new seams. In Wales extensive employment was being provided on the production of railway iron for the United States, and large orders for Canada were being anticipated. From Barrow came the news that a flax and jute mill would shortly start work, that a wire mill had been completed, that an iron rolling mill and a wagon factory had been begun, and that the construction of a shipbuilding and engineering establishment was in a forward state. Yet if trade were prosperous, our manufacturers were not without their troubles. There were sectional strikes in the coal, iron, engineering and shipbuilding industries. At Newcastle the Nine Hours' League was active. It had 2181 people and 2828 children on its books and was allowing the strikers 6s. a week for each adult and 1s. a week for each child. The strike had begun three months previously. In an endeavour to defeat it the engineering employers had imported workers from London, Cornwall, Belgium, Norway, Denmark and Prussia. But in a short time these men began to complain of the conditions offered them, and in the end walked out and joined the Nine Hours' League. On the Clyde the shipwrights at most of the yards were on strike for an extra 3s. per week. The masters offered an advance of 1s. 6d. for a sixty hours' week, but the terms were refused and the trouble showed signs of spreading.

The Grampian Hydro-Electric Power Scheme.

No. IV.*

Valve House and Pipe Line.

Sections through the valve house are given in Fig. 26 and interior views in Figs. 33, 34, 35 and 36 on page 222. The orifices in the two arms of the breeches pipes in the valve house are 8ft. in internal diameter. Their inverts come at an elevation of 1026·17 O.D. As the invert level at the inlet to the tunnel is 1072·00 O.D., there is a fall of 45·83ft. in a total of 14,300ft. length of the tunnel, which represents an average gradient of about 1 in 312. For the purposes of the present development there are two lines of pipes running from the valve house at the portal down to the power-house. They were manufactured and supplied by the South Durham Iron and Steel Company, Ltd. Each of these pipes is 94·5in. in external diameter and the pipes were made in 24ft. lengths with three plates to the circumference. The plates varied in thickness from ¼in. at the top, where the static head is some 55 lb. per square inch, to 1¼in. at the bottom, where the static head amounts to nearly 220 lb. per square inch. The laid length of each pipe line is 2701·75ft. measured on the horizontal and the fall from the valve house to the turbines is some 358ft., which represents an increase in pressure of about 155 lb. per square inch. The pipes are, we believe, the longest pipes of their diameter and thickness which have hitherto been made in this country. In manufacture the longitudinal joints were shop welded, and the circumferential joints, which are of the spigot and socket design, were riveted on the site, a double line of rivets being employed in each case. The rivets varied from ⅞in. diameter at the top of the pipe lines to 1¼in. diameter at the bottom. We are informed that, so well was the work of erection and riveting carried out, when the pipe lines were tested to a head 30 per cent. in excess of the designed head there was no sign of leakage either at the joints or at any of the rivets. The pipes are supported at distances of 48ft. apart on concrete piers 2ft. wide, being carried on roller bearings to allow for expansion and contraction. The roller bearings are of the type usually employed in bridge work. The pipe lines are anchored at six points, the first five of which are by means of massive concrete anchor blocks arranged at varying centres, while the sixth is an anchorage forming part of the power-house foundations. Below each of the first five anchorages there is an expansion joint of the usual stuffing-box design, and access manholes are also provided at those points on the lower quarter in the pipe diameter. Various views of the pipe lines are given in Figs. 27, 28, 29, and 30.

As the pipe lines enter the power-house they are embedded in a solid mass of concrete. A pipe line leads to each of the two turbines installed. At the end of each pipe line there is a tapering connection in which the 94½in. pipe is reduced to 48in., where junction is made with the main valve to the turbine.

In the valve house between the two outlets of one of the breeches piece and the pipe lines there is a 96in. diameter hand-operated stop valve, and then an automatic valve of the same diameter, which is of the butterfly type and which is designed to close should the velocity of the water in the pipe line exceed the designed maximum flow by 50 per cent. These valves, which were supplied by Glenfield and Kennedy, Ltd., and which can also be controlled in emergency from the switchboard in the power-house, are of the makers' standard types and, saving as regards their size, they are identical with those for the Maentwrog undertaking of the North Wales Power Co., Ltd., which have already been described in our columns.

On the power-house side of these automatic valves there are on each line of pipes two anti-vacuum air valves. The purpose of these valves is to admit air freely into the pipes to prevent collapse as the result of exterior atmospheric pressure should the automatic stop valves in the valve house, owing to any emergency, ever come into operation. They are identical in design with the valves of the same type and for the same purpose which we have previously described and the only difference in their application in the present instance is that, instead of both being on the centre line of the pipe, they are arranged abreast of one another. This construction, which has the advantage of saving space in the valve house, was possible on account of the large diameter of the pipes.

As regards the second breeches piece in the valve house, one branch—that next to the pipe lines already in operation—is furnished with a hand-operated stop valve, which is, for the time being, closed with a blank flange. Eventually, when the scheme is further developed and the level of Loch Ericht raised, a third pipe line, similar to the two already in position, will be laid from that valve down to the power-house. For the moment, however, it will remain as we have described it. The other branch of this breeches piece is closed with a blank flange from which connections are taken off for the estate water supply, including the shooting lodges. The weight of steel comprised in

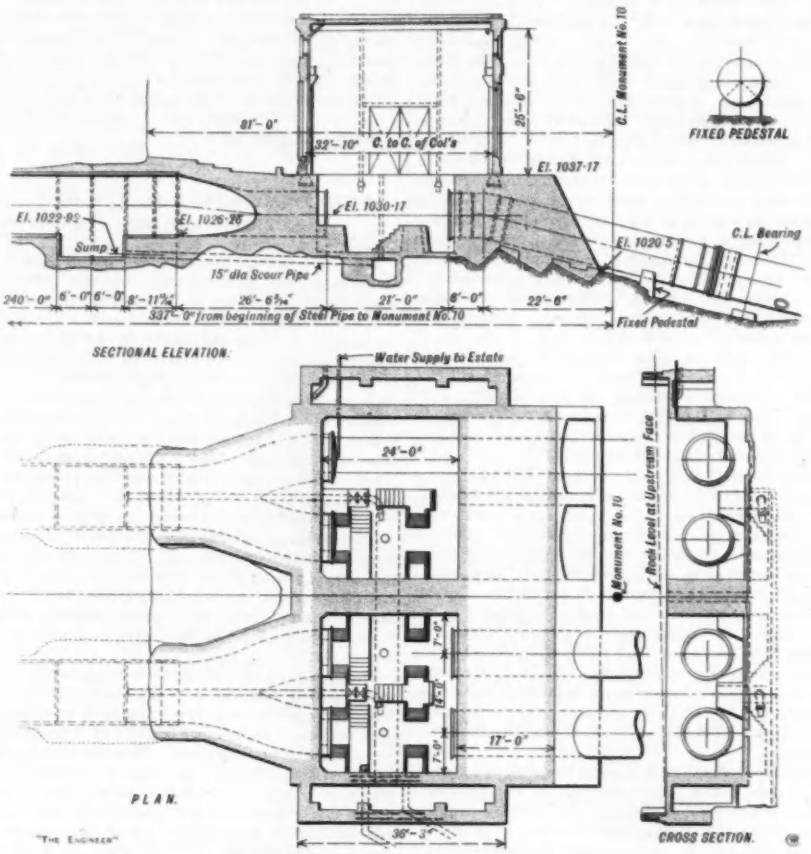


FIG. 26—SECTIONS AND PLAN OF VALVE HOUSE

FIG. 27—PIPE LINE FROM POWER HOUSE

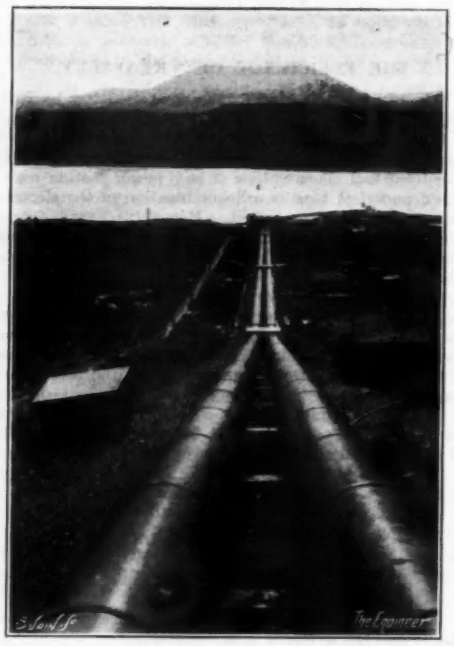


FIG. 28—PIPE LINE FROM VALVE HOUSE

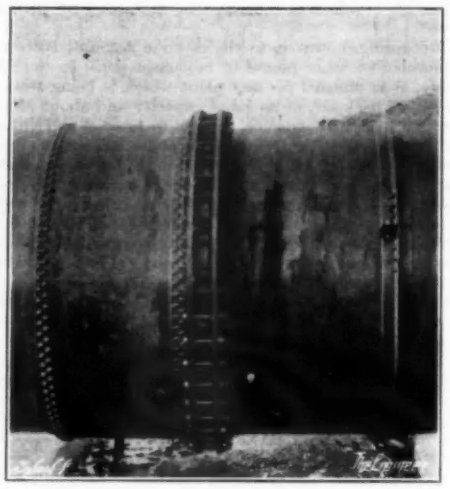


FIG. 29—EXPANSION JOINT IN PIPE LINE

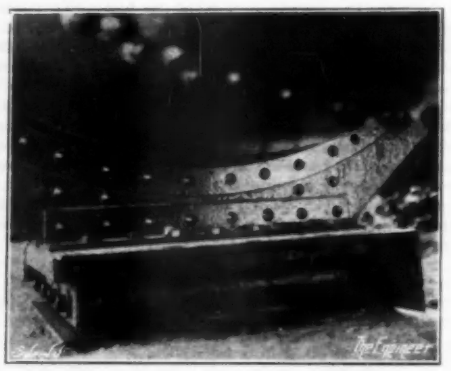


FIG. 30—ROLLER BEARING UNDER PIPE LINE

* No. III. appeared August 21st.

the river crossing and in the pipe lines is, approximately, 2400 tons.

The valve house itself does not call for particular comment. It is a steel and concrete structure and is equipped with a hand-operated overhead travelling crane of 10 tons capacity.

GENERATING STATION.

The power-house, drawings of which are given in Figs. 31 and 32, has been erected not far from the north bank of Loch Rannoch. It is a handsome building constructed with smooth-faced and rock-faced concrete block work, the steel work having been supplied by Redpath, Brown and Co., Ltd. It measures 95ft. long by 50ft. wide, and it is 46ft. high to the roof in that portion in which the generators come. At a height of 20ft. above the floor there is a wide gallery, which is approached from the generator floor level by two staircases and is protected by a substantial handrail. On this gallery, from which there is a full view of the generators, &c., is arranged the controlling switchgear. Running the whole length of the house, over the generating units, there is an overhead travelling crane carried on rails 31ft. high from the floor. The crane, which is electrically-operated and has a capacity of 50 tons, has a span of 36ft. 3in. and was supplied by Royce, Ltd., of Manchester. At the present time only two generating units have been installed, but all the work necessary for putting in a third set has been done up to the formation of the foundation for it. The building itself is founded upon solid rock. Two culverts have been provided to lead away any water which may enter as the result of accidental leakage from the pipe lines. These culverts were put in as a safety measure, and the windows were omitted from the walls of the power-house at the alternator floor level.

Of the two generating units at present in position each comprises a vertical-spindle pressure-reaction type turbine made by the English Electric Company, Ltd., designed to develop its full output of 22,000 horse-power under a net head of 515ft. at a speed of 500 r.p.m. and to work at a maximum static head of 541ft. In order to allow for a varying head of water the efficiency curve from 50 per cent. to 100 per cent. has been made very flat, the peak value corresponding to 80 per cent. of full load under a head of 465ft.

The water supply to each turbine is controlled by an Escher-Wyss rotary valve having an internal diameter of 4ft. 6in. This valve is fitted with automatic closing arrangements, so that, in the event of the water velocity exceeding the normal value by more than 50 per cent. it is automatically closed. It may also be closed in an emergency by remote electrical operation from the switchboard. The spiral casings of the turbines are of cast steel and are heavily stayed, while the runners are made of a special alloy bronze, which, it is anticipated, will give continuous service for many years, being of a highly resistant character. Provision was made on the turbines for the easy dismantling of the upper part of the draught tubes in order to allow the runners to be taken out on a truck which runs on rails to a point directly under a circular opening formed in the flooring of the alternator room, which is immediately above the turbine chamber. There are three of these openings, one for each turbine. The runner can then be lifted through the opening by the station crane. When in position the runner is coupled by a short stiff turbine shaft to the alternator which is immediately above it. Both shafts were carefully fitted together at the generator manufacturer's works before dispatch to the site. In the design of these turbines particular attention was paid to accessibility. Individual guide vanes can be lubricated and adjusted while the machine is in service. The vanes are protected against obstruction by breaking links.

The whole weight of the rotating parts of the turbine, as well as the downward component of the hydraulic thrust, are taken by the generator thrust bearing. There is, however, a single turbine guide bearing. It is white metal lined, and is oil lubricated and water cooled, being protected by a thermostat which forms part of the station automatic system. The oil supply is furnished either by hand pump, gear-driven pump, or motor-driven pump. The hand pump is used for starting up and, normally, the gear-driven pump is used when running, the motor-driven pump serving as a standby.

For controlling the speed of the turbines there are two highly sensitive automatic governors of the oil pressure type. The governor for one machine was supplied by the makers of the turbines—the English Electric Company, Ltd.—while that for the other was made by Boving and Co., Ltd. These governors, which operate on to the turbine guide vanes, and which are arranged at the alternator floor level, effect an exceedingly close speed regulation, being sensitive to speed variations of one-tenth per cent., the maximum momentary speed variation being controlled so as not to exceed from 16 to 17 per cent. when the full load is thrown off. Each turbine is fitted with a cylindrical relief valve controlled by the governor, which ensures that the pressure rise in the pipe line is limited to a maximum of 10 per cent. under all conditions of reduction of load on the generator. The relief valve, which is of the English Electric Company's cylindrical balanced type, forms a direct prolongation of the spiral casing of the turbine. The governors are actuated by oil pressure provided by a Pelton wheel-driven pump. The arrangements are such that, if the oil pressure were to fail, the governor would automatically close down the set. The automatic devices also ensurp shutting down on the occurrence of overspeed or underspeed, or should the gear driving the governor gear fail. A

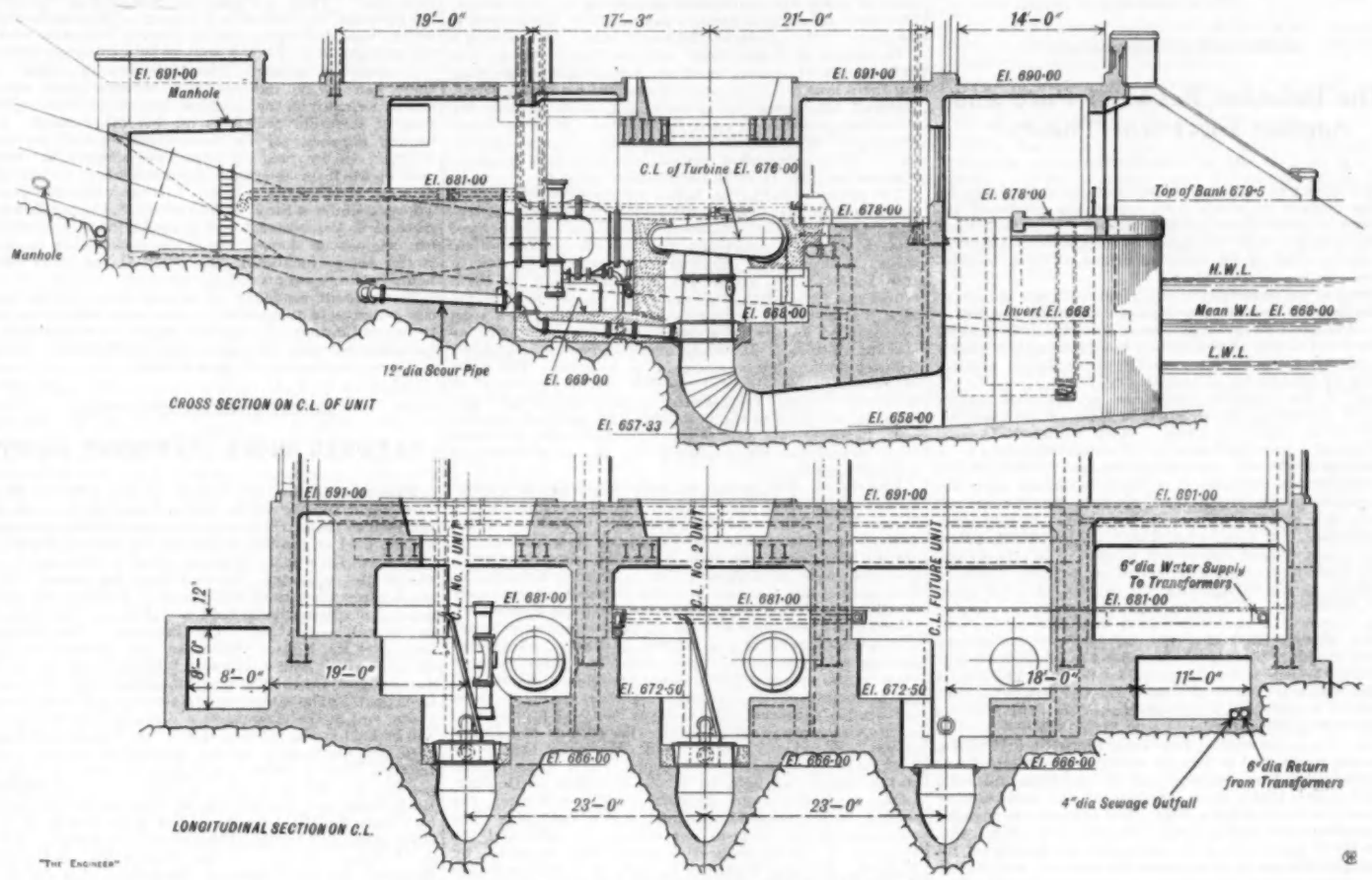


FIG. 31—CROSS AND LONGITUDINAL SECTIONS OF POWER HOUSE

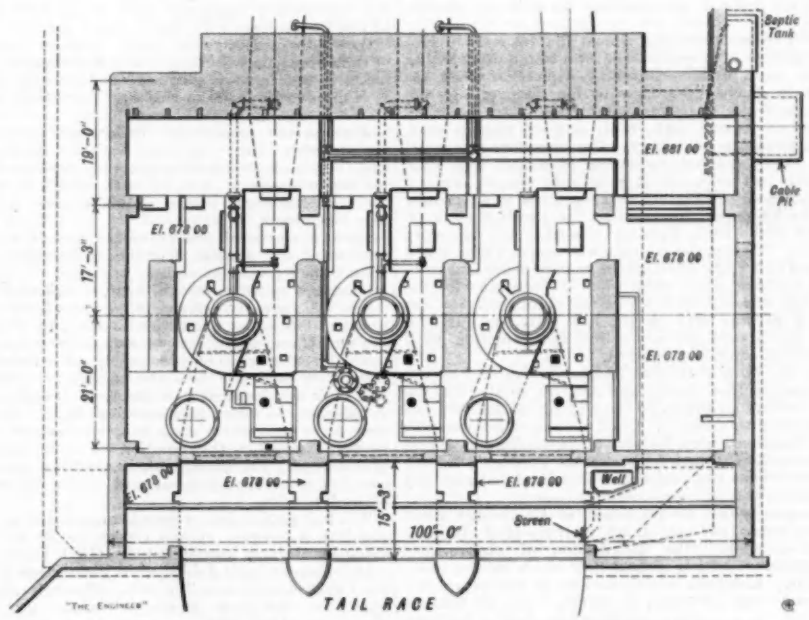


FIG. 32—POWER HOUSE—PLAN BELOW ALTERNATOR FLOOR

solid-way shaft 11in. in diameter transmits the motion of the governor servo-motor from the upper to the lower floor. In addition to the automatic control, the governors can be controlled so as to raise or lower the speed from the main switchboard, so as to simplify the operations of synchronising and load adjustment. The connecting-rods between the gate apparatus, the relief valve mechanism, and the governor servo-motor have been made exceptionally heavy so as to ensure absence of "lost motion."

(To be continued.)

The Relation Between Pure and Applied Electrical Theory.*

By G. WINDRED.

The history of electrical theory contains many examples of the manner in which pure science has produced discoveries of great practical importance. It is the object of the present paper to trace, by means of a historical retrospect, some of the more important of these developments.

There is an unfortunate deviation between the views of the theorist and the practitioner concerning the usefulness of theoretical investigations. A study of the history of electrical theory shows that in reality these two classes are closely related, the progress of electrical practice having its foundation in pure theory.

One of the greatest discoveries in electrical history was the observance by Oersted, in 1820, of the magnetic effect of an electric current. Hans Christian Oersted (1777–1851) was Professor of Natural Philosophy in Copenhagen. As early as 1807 he announced his intention of examining the effects of an electric current upon the ordinary magnetic needle. We are told that he was not a very able experimenter, and was obliged to rely upon an assistant for the arrangement of his experiments. Many years elapsed before the advent of his discovery, which took place during a course of lectures which he delivered at Copenhagen in the winter of 1819–1820, on "Electricity, Galvanism and Magnetism." During these lectures, he observed that a wire carrying current from a battery affected a compass needle in its vicinity in such a manner that the needle tended to set itself at right angles to the wire so long as a current flowed. The results of this discovery were published by Oersted in a tract entitled "Experimenta circa effectum Conflictus Electrici in Acum Magneticam," dated July 21st, 1820.[1]

Oersted's experiments were soon repeated in France, with the result that a detailed analysis of the effect was announced by Jean-Baptiste Biot (1774–1862), and Félix Savart (1791–1841), at a meeting of the Academy of Sciences on October 30th, 1820. The subject also engaged the attention of André Marie Ampère (1775–1836), who, after three years' research, published the results of his investigations in a mathematical memoir which will ever remain among the classics of electrical theory. This memoir contains the first conception of the "magnetic shell," which is of such great importance in electro-magnetic theory, and an expression for the force between two current elements which established the laws of mechanical action between electric currents. In his famous "Treatise on Electricity and Magnetism," James Clerk Maxwell (1831–1879), refers to Ampère's memoir as follows: "The whole, theory and experiment, seems as if it had leaped, full grown and full armed, from the brain of the 'Newton of electricity.' It is perfect in form, and unassailable in accuracy, and it is summed up in a formula from which all the phenomena may be deduced and which must always remain the cardinal formula of electro-dynamics."

Oersted's experiments had shown that electricity produces magnetism. It was now natural to inquire whether magnetism could produce electricity, a question which was answered by Michael Faraday in his discovery of the phenomenon of electro-magnetic induction. This discovery took place on August 29th, 1831, and the present year, therefore, marks its centenary. The discovery was made with an electro-magnet consisting of a soft iron ring, upon which two independent coils were wound, one coil being connected to a battery and the other to a galvanometer. In his paper presented to the Royal Society on November 24th, 1831, Faraday describes his discovery as follows: "When the contact was made, there was a sudden and very slight effect on the galvanometer and there was also a similar slight effect when the contact with the battery was broken. But, whilst the voltaic current was continuing to pass through the one helix, no galvanometrical appearance nor any effect like induction upon the other helix could be perceived."

Just as the work of Oersted had been advanced by the mathematicians Biot, Savart and Ampère, so also was the work of Faraday advanced by the English mathematicians of the nineteenth century. Chief among these were Sir William Thomson (Lord Kelvin) (1824–1907), and James Clerk Maxwell, who had both studied Faraday's experimental researches and had noted therein the clarity and logic of his deductions.

In a paper which he published at Cambridge when seventeen years of age, Lord Kelvin—then William Thomson—compared the distribution of electrostatic force to the distribution of heat flow in an infinite solid. This analogy had been anticipated some five years previously by the French geometer, Michel Chasles (1793–1880), in a memoir published in 1837. In 1846 Thomson published a further paper having as its subject the analogy between certain electrical phenomena and elasticity. From an examination of the equations of equilibrium of an incompressible elastic solid in a state of strain, he showed that the distribution of the elastic displacement was analogous to the distribution of electric force in an electrostatic field.

Lord Kelvin's ability in devising mechanical models and analogies was characteristic of the Cambridge school of thought. It was shared also by Clerk Maxwell, who published his first mathematical interpretation of the conceptions of Faraday in a paper[2] presented to the Cambridge Philosophical Society, when twenty-four years of age, and shortly after his election to Fellowship of Trinity College. In Maxwell was vested the rare combination of a first-class mathematical ability and a keen insight of physical phenomena, which enabled him not only to grasp the conditions underlying an experiment, but also to express these conditions in mathematical language. He made a thorough study of Faraday's "Experimental Researches," and resolved to bring them to the notice of contemporary mathematicians by translating them into a mathematical form. In his first memoir, Maxwell attempted to identify the ideas of Faraday with the analogies devised by Kelvin. By identifying Faraday's "lines of force" with the lines of flow of a liquid, he was able to show that the magnetic induction is expressible as the velocity of an incompressible fluid.

The prosecution of these methods of inquiry led Maxwell to formulate his famous dynamical theory of electro-magnetism and the "Maxwell Equations," which have played such an important part in the mathematical theory of electricity. Maxwell's "Treatise on Electricity and Magnetism," which was first published in 1873, represents a complete development of his earlier attempts at a mathematical interpretation of Faraday, and may be regarded as the groundwork of electrical theory as it is known to-day. It stands in itself as one of the greatest tributes to Faraday as a natural philosopher. The work of Faraday and Maxwell, carried on in the spirit of discovery for the furtherance of pure knowledge, and without any heed to the possibilities of practical application, has provided the practitioner with the materials from which has been created the whole of electrical engineering practice.

The theory of signalling by cable originated in a correspondence between Lord Kelvin and Sir George Gabriel Stokes (1819–1903) in 1854. The work of Kelvin on this subject was extended in 1857 by Gustav Robert Kirchhoff (1824–1887), who showed that the electro-magnetic disturbance is propagated with a definite velocity, C. The value of this constant had been determined previously by Wilhelm Weber (1804–1890), and Rudolph Kohlrausch (1809–1858), who showed by a comparison of two different methods of discharging a Leyden jar that $C = 3{\cdot}1 \times 10^{10}$ centimetres per second approximately. This is very close to the value of the velocity of light as determined by astronomical observations. The average of three independent observations of the velocity of propagation of electro-magnetic waves in air—Trowbridge and Duane (1895), Saunders (1897), and Maclean (1899)—is $2{\cdot}997 \times 10^{10}$ centimetres per second. The measurement of the velocity of light by A. A. Michelson in October, 1924, gave the value $2{\cdot}99735 \times 10^{10}$ centimetres per second, with a possible error of one part in 22,000. The close agreement between the velocity of light and the velocity of electro-magnetic waves was observed by Maxwell, and was regarded by him as a strong reason for believing that light is an electro-magnetic phenomenon. To Maxwell is due the electro-magnetic theory of light, concerning the scientific importance of which the present state of optical theory does not permit us to speculate.

An outstanding example of the relationship between pure and applied electrical theory is afforded by the modern theory of electrons founded by Sir J. J. Thomson at Cambridge towards the end of last century. This highly abstract theory is one of the last from which we would anticipate the emergence of practical utility, and yet the electron has made possible the conveyance of wireless messages with a consequent inestimable value to mankind. The use of X-rays in surgery and medicine has enormously improved these sciences to the benefit of the human race. In the words of Sir J. J. Thomson, "these discoveries were made without any thought of such applications; they illustrate the value of research made solely for the purpose of advancing knowledge. It is discoveries made in this way that create new industries and revolutionise old ones."

Just as the practitioner builds upon the results of the research worker, so also does the research worker and theorist depend greatly upon the pure mathematician for the weapons of analysis with which to achieve his results. Electrical theory provides many examples of this dependence.

Modern electrical theory makes use of a very large portion of the domain of pure mathematics. In A.C. circuit theory and in certain problems of electrostatics involving a two-dimensional form of Laplace's equation, much assistance is derived in practice from the use of so-called "complex quantities," relying for their physical interpretation upon the unassignable square root of minus 1[3]. The origin of these purely mathematical conceptions goes back far into the history of mathematics,[4] and their development has, strangely enough, often been in advance of strict mathematical logic. Nevertheless, they have proved of great practical value; they have rendered possible the solution of otherwise insoluble problems of great importance in electrical circuit theory, the theory of electrostatics and analogous problems in hydrodynamics.

The first application of complex quantities to a practical problem in electric circuit theory seems to have been made by Herman von Helmholtz (1821–1894) in a paper on telephone theory published in Weidemann's "Annalen der Physik und Chemie" in 1898. The method of complex quantities was also employed extensively by Oliver Heaviside (1850–1925), notably in a series of papers "On the Self-induction of Wires," published in 1886 and 1887. Further applications of the method were made by Adolf Franke, in a paper on the theory of telephone networks published in 1891.

In 1893 the method of complex quantities was applied to the general theory of A.C. circuits by Arthur Edwin Kennelly, whose paper on "Impedance," published in the "Transactions" of the American Institute of Electrical Engineers for April, 1893, contains the first application of complex representation to electrical technology. The methods here instituted were developed, notably by Dr. Charles Proteus Steinmetz (1865–1923), and have become of fundamental importance in the general theory of A.C. circuits and in the solution of transmission line problems.[5] Thus, we have an outstanding example of the practical application of a branch of pure mathematics, which was developed during several centuries without the thought of ever being applied for utilitarian purposes.

A study of scientific history makes it evident that there can be no independence between pure research and experiment on the one hand, and the practical application of scientific principles on the other hand. Each branch depends for its development upon the other. Neither can we regard pure mathematics as distinct and apart from scientific developments; it has given us some of the most valuable theories which we possess. To use a simile of Sir J. J. Thomson: "The mathematical method is the better for developing ideas, the physical for originating them; the mathematical, so to speak, is the better incubator, the physical the more prolific hen; both are essential."

The present tendency of intense specialisation makes the progress of science more than ever dependent upon the co-ordination of pure and applied theory which can be achieved only through close collaboration between the pure theorist and the practitioner.

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* Paper presented before the Second International Congress of the History of Science and Technology on July 3rd.

[1] There is a German translation from the Latin in "Zur Entdeckung des Elektromagnetismus" (Ostwald's Klassiker Nr. 63), Leipzig, 1895, and an English translation in Thomson's "Annals of Philosophy," xvi (1820), p. 273.

[2] "Transactions," Camb. Phil. Soc., x, p. 27.

[3] See the author's papers: "Complex Numbers in Engineering," *The Electrician*, xcviii, pp. 142–145; "The Complex Number and its Use in Electrical Theory," *ibid.*, ci, pp. 173–174, 201–203; "Electrical Circuit Theory Based on the Method of Complex Numbers," *ibid.*, cii, pp. 409–411, 437–438.

[4] See the author's paper: "History of the Theory of Imaginary and Complex Quantities," *Mathematical Gazette*, xiv, Oct. 1929. pp. 533–541.

[5] See the author's paper: "Early Developments in A.C. Circuit Theory," *Phil. Mag.*, x, Nov. 1930, pp. 905–906.

NATIONAL SMOKE ABATEMENT SOCIETY.

The third annual conference of the National Smoke Abatement Society will be held at Liverpool from September 18th to 20th. On Friday, September 18th, a reception will be held at the Town Hall at 8 p.m., when the Lord Mayor of Liverpool, Alderman Edwin Thompson, will receive the delegates. On Saturday, September 19th, in the Lecture Theatre of the School of Hygiene, the annual general meeting will be held at 9.45 a.m. At 11 a.m. a paper will be read on "The Progress of the Electrical Grid," by Mr. Robert Blackmore. At 12 noon Mr. Ralph E. Gibson will read a paper on "Some Notes on the Production and Use of the new Smokeless Fuel 'Dryco' in Liverpool." The afternoon of Saturday will be devoted to visits, and in the evening, at 8 p.m., an informal meeting will be held at the Adelphi Hotel. On Sunday, September 20th, the Conference will be resumed at 11 a.m., in the Lecture Theatre School of Hygiene, when the following papers will be read and discussed:—"The Sheffield, Rotherham and District Smoke Abatement Committee," by Councillor W. Asbury; "The West Riding of Yorkshire Regional Smoke Abatement Committee," by Dr. J. Johnson Jervis; "The Manchester and District Regional Smoke Abatement Committee," by Dr. James Bennett; "The Greater London Joint Smoke Abatement Committee," "The Midlands Joint Advisory Council for Smoke Abatement." At 12.15 p.m. a demonstration of the apparatus used for the measurement of atmospheric impurities will be given by Mr. W. H. Roberts. The Conference will conclude with a Council meeting at the Adelphi Hotel at 3.30 p.m.

OIL-ELECTRIC RAILWAY MOTOR CAR.

One of the many self-contained cars now in operation for branch line and intermediate service on American railways is an oil-electric car operating a 240-mile service on the Erie Railroad. It hauls one or two trailers and makes frequent stops, thus supplementing the fast trains making few stops. The car is 75ft. long over the body; at the forward end is the engine-room, 18ft. long; then a mail or railway post-office room, 30ft.; and a luggage compartment, 27ft. Passengers are carried in the ordinary cars or trailers. In the engine-room are two four-stroke cycle, airless-injection oil engines of 300 H.P. each when running at 800 revolutions. Fuel oil from 600-gallon tanks under the frame is delivered to the engines by electric pumps. Each engine has oil clarifiers, and is cooled by having the jacket water and lubricating oil pumped through fan-cooled radiators on the roof. Each engine serves a main generator, auxiliary generator, and two traction motors, giving a gear ratio of 20·5 to the axles. A 32-cell battery supplies current for starting the engines, lighting and auxiliary circuits. An oil-burning boiler in the baggage room supplies steam heat for the car and the attached passenger cars. There are two four-wheeled bogies, with 36in. driving wheels and 7½ft. wheel base, all axles having roller bearings and each being driven by its own motor. The car is of steel throughout, and its appearance is that of an ordinary combination mail and baggage car. It weighs 85 gross tons; and has a starting tractive force of 22,600 lb., with a continuous tractive force of 5700 lb. at 28 miles per hour. It can attain a speed of 75 miles per hour, and its schedule for the 240-mile run is 30 miles per hour, including all stops, so that the intermediate speeds run up to about 40 or 45 miles per hour. A "deadman's" pedal at the driver's seat applies the air brakes if it is released while current is being delivered to the motors.

The Pretoria Town Council is about to install a new 12,500-kW Parsons turbo-alternator in its power-house. It is to generate at 12,000 volts, as compared with the 6600 volts of the present plant, and will consequently involve some alterations to the switchgear and transformers.

Railway and Road Matters.

THE slot automatic ticket-issuing machines, used on the Metropolitan District and tube railways, were first used before the war and were made by a German firm. That condition has prevailed since, because, to quote *The Times* of August 20th, "no British firm has succeeded in inventing one that was trustworthy and fulfilled the requirements of the Underground Railways." It is now announced that six machines, made by Messrs. Brecknell, Munro and Rogers, of Bristol, are under test at Highgate.

THE closing of unprofitable branch lines is spreading to Ireland; the Birdhill and Killaloe branch was closed on August 17th, and the Kinsale Junction–Kinsale branch will be shut down on September 1st. A far more serious matter is the intimation that the Cavan and Leitrim line may have to be closed very shortly. It is now part of the system of the Great Southern Railways and runs from Belturret to Dromore on the Sligo line, 33 miles, with a branch from Ballinamore to Arigna, 15 miles. It is of 2ft. 6in. gauge.

ON the retirement of Captain Myddleton Beasley from the position of chief marine superintendent of the London, Midland and Scottish Railway, the directors of that company have appointed Captain James Whyte Harris, R.N.R., marine superintendent of the Booth Line, as his successor. In anticipation of the inauguration of the Midland Railway Company's Belfast and Heysham service on September 1st, 1904, Captain Beasley was appointed harbour master at Heysham and was made that company's marine superintendent in 1915.

THE passenger and goods train working tables of the Southern Railway for June show that of 89,556 steam-worked trains 75·33 per cent. arrived at their destination on time and of the remainder 19·36 per cent. of the total were not more than five minutes late. Of the 92,785 electrically-operated trains the corresponding figures were 80·10 per cent. and 18·10 per cent. What we consider a yet more creditable performance was that of 16,206 goods trains 91 per cent. arrived on time. The average late start of the goods trains was only 1·4 minute.

IN our account in THE ENGINEER of September 19th, 1930, of the celebrations in commemoration of the centenary of the opening of the Liverpool and Manchester Railway, we mentioned that one of the old locomotives exhibited in the historical pageant at Wavertree was the "Lion" of the Liverpool and Manchester Railway, which had been restored to working order at Crewe. We added that the "Lion" was to become a permanent exhibit at Lime-street Station, Liverpool. The ceremony, we are now in a position to announce, will take place on September 15th.

IT was twenty years on the 18th and 19th instant since the general strike of railwaymen. It arose out of the disappointed hopes of the men at the benefits which were expected from the conciliation scheme set up, at the instance of Mr. Lloyd George, when President of the Board of Trade, in 1907. As a result of the strike a Royal Commission recommended a new conciliation scheme, which came into being in November, 1911, and which, mainly because of give-and-take by both sides, remained in being until displaced by the Central and National Wages Boards in 1919.

FOLLOWING up the note herein on July 17th as to the consumption of lubricating oil per engine mile, we would say that the Railway Returns for 1930, just issued, show that, for all British railways, the consumption of oil per 100 miles last year was 6·50 pints, as compared with 6·63 pints in 1929. The total amount consumed was 35,331,144 pints, as against 36,947,035 pints in 1929. Corresponding information is given as to the coal consumption. That was 53·19 lb. per engine mile, as compared with 54·02 lb. per engine mile in 1929, and the total consumption was 12,874,543 tons in 1930 and 13,413,308 tons in 1929.

LAST Sunday, August 23rd, the first of the colour light signals now being installed between Paddington and Southall on the G.W.R. was brought into use at Subway Junction signal-box near Paddington Station. These signals will replace the semaphore arm signals hitherto used. At the moment the whole of the track between Paddington and Southall has been equipped with the necessary wires and standards and before the winter is out it is hoped to complete the fitting of the lights to the new signal standards throughout the whole of this 9-mile stretch of line. When completed the scheme will have cost in the region of £60,000.

THE inquiry as to statistics of railway accidents which has reached us from the Railway Staff College, at Dehra Dun, under the control of the Indian Railway Board, prompts us to say that that institution was opened on April 3rd, 1930, by Sir Malcolm Harley, the Governor of the United Provinces. It has a frontage of 360ft. and consists of a large hall, containing a complete model railway, another model room, where principally rolling stock models are exhibited, lecture rooms, examination rooms and offices. The cost was about £187,500. The course of instruction lasts about two months. It covers lectures on the general rules for working railways, the theory and practice of transportation, train control, the commercial work of railways, traffic accounts, telegraph office work, and the elementary principles of the locomotive and the vacuum brake. Fourteen of the first sixteen students—from seven railway systems—passed the ensuing examination. A refresher course, for junior officers, of a more advanced character, led to ten out of twelve officers passing. There are now lectures for probationary civil engineers. A fuel-economy course in February-March, 1930, had twenty-two students. There are also what are termed area schools at Chandausi, Asonzal, Bina and Lahore. The last-named is said to have given the North-Western Railway the most complete and up-to-date school in India. Its model room is equipped with a 2½in. gauge track, electrically operated, on which sixteen stations and twenty-one signal-boxes are represented. Full-sized block instruments are in use, and twenty-five students can work in the model room at the same time. Facilities are also given for the study of locomotive equipment, vacuum brake gear and points, crossings, and other permanent way details.

Notes and Memoranda.

IN the construction of the new wharves at Portland, Maine, about 8000 wood piles were used, some of which are as long as 129ft.

IN the manufacture of each pound of rayon by the viscose process, there are used 1½ lb. of wood pulp, 2 lb. of caustic soda, 1½ lb. of carbon bisulphide, and 1½ lb. of sulphuric acid.

ACCORDING to estimates made by the U.S. Geological Survey, the capacity of the waterwheels in the constructed plants of the world was 23,000,000 H.P. in 1920, 29,000,000 H.P. at the end of 1923, 33,000,000 H.P. at the end of 1926, and 46,000,000 H.P. at the end of 1930, an increase of 100 per cent. in ten years.

A RUSSIAN engineer, A. M. Gunzburg, has evolved a system of laying concrete in cold countries, notably the Ukraine, in which he allows the concrete to freeze so quickly, on pouring, that it has not time to set. Then, in the spring, it thaws out and is encouraged to set by the addition of further water.

A CHART, which has been named the Arcograph, is being issued gratis by the *Welder*, of Ferry-lane Works, Forest-road, London, E. 17. It gives at a glance data relative to the electric welding of plates from ⅛ in. to 1in. in thickness. The information covers the angle of bevel, the number of runs required, and gauges of electrodes, ampères for each gauge, feet of electrodes required per foot of seam, number of minutes to complete, and units of current used per foot of seam.

IN its magnetic properties bismuth is also an unusual metal. It is the most diamagnetic of all metals; instead of being attracted like iron to a magnet, it is strongly repelled by either pole. This property is less at higher temperatures. An alloy of bismuth with copper and manganese—which are likewise diamagnetic, though to a much less degree—is distinctly magnetic. When bismuth is placed in a magnetic field it becomes a better conductor of both heat and electricity.

AN unusual experiment was made on an oil engine recently by its makers, R. A. Lister and Co., of Dursley. The engine was of the airless injection heavy-oil type, which we have described. After running for some time in the ordinary way its cooling water connections were disconnected and it was put into a cold storage chamber for the night. The temperature was reduced to 2 deg. Fah., but the engine was easily started by hand in the morning as soon as it was taken from the refrigerator.

UNDER the name "Sakaloid," a new plastic has, according to the *Chemical Trade Journal*, been announced in the U.S.A., the principal constituent of which is polymerised sugar. The process involves the use of any commercial sugar, molasses, or glucose, which is boiled to a thick syrup, filtered, and then treated with an aldehyde or similar polymerising agent, with or without the presence of a catalyst, depending on the properties desired. This product varies from a water soluble gel to a hard, brilliant, water-white solid which can be moulded. It is said to have a light permeability ranging through the ultra-violet, and does not discolour with age.

AN all-welded hopper car of 95 tons capacity for carrying coal has, says the *Iron Age*, been in use on the Baltimore and Ohio since October, 1929, and is said to have given excellent results in service. The car has four transverse hoppers extending along its central length between the bogies. Four additional corner hoppers are located between the bolsters and the ends of the car. These provide increased capacity and give also an end discharge of the load across the track. Except for the hoppers themselves, the entire body has been built up by welding. With total capacity of 3507 cubic feet, the new car has an allowable load limit of 193,200 lb. on a weight of 57,800 lb. The ratio is 3·34 lb. of "pay" load for each pound of tare. This compares with 154,400 lb. allowable load limit on standard-construction hopper cars built by the railway in the same year, with tare weight of 55,600 lb. Here the ratio is 2·78 to 1.

SOME of the tubes of a water-tube boiler in a Middlesbrough factory pulled out of the steam drum, obviously on account of shortness of water. Commenting on the mishap, the Engineer Surveyor-in-Chief, Board of Trade, says: "Although the management in this case considered the firemen competent to take full responsibility for the safe working of the boilers, want of proper supervision resulted in the simple and necessary operations of regular testing and periodical renewal of the water gauge glasses being neglected. It is incumbent upon the owners of steam boilers to see that the safe working is supervised by someone thoroughly conversant with what is necessary to maintain that condition. High and low-water level alarms form a convenient check on extreme water levels in a boiler, but should not be relied upon to the extent of neglecting the ordinary water gauges, as their accuracy cannot be definitely checked with steam on the boiler, whereas properly designed and fitted gauges of the ordinary type can be tested and a positive reading of the water level obtained.

A RECENTLY completed spectroscopic study at the Dominion Astrophysical Observatory, at Victoria, British Columbia, of a faint star named H.D. 698 in the constellation of Cassiopeia, proves that it is the most massive yet discovered. The binary system consists of two giant suns of masses 134 and 50 times our sun, separated by a distance of 150,000,000 miles, which revolve around one another in slightly less than fifty-six days. The orbital velocities of the two stars are 53 and 142 miles per second respectively. The analysis of their light shows that the smaller component has a temperature of 25,000 deg. Fah., and volume 135 times the sun, and is intrinsically about 350 times as bright. The larger star has a peculiar spectrum. Besides containing the ordinary hydrogen and helium lines of a high-temperature star, it has, in addition, many lines of the enhanced metals, such as iron, titanium and chromium, usually found in cooler stars. This—and the additional observation that all the lines are narrow—indicates that the density is abnormally low and that the star is an exceedingly large one. The computed volume is 3550 times the sun, the temperature 18,000 deg. Fah., and the luminosity 1400 times that of the sun.

Miscellanea.

THE Barrow-in-Furness Town Council proposes to expend £20,000 on electricity supply extensions.

A NEW engine erecting shop, covering an area of 16,500 square feet, is being put up for the Rhodesian Railways at Mafeking.

IT is said that extensive deposits of oil have been discovered in the Dead Sea district of Palestine, at depths of from 2500ft. to 3200ft.

A MATCH factory, capable of producing 240 cases a day, is to be put up at Belvedere, Kent, by the International Match Corporation of Great Britain.

THE hydro-electric power plant at Slave Falls, on the Winnipeg River, Manitoba, is to be opened on September 1st. It has a capacity of 96,000 horse-power.

THE Soviet aeroplane works have constructed an all-metal aeroplane with five engines of 2400 H.P. altogether. The machine will accommodate forty-one passengers.

ACCORDING to a report in a continental paper, the Bengal-Nagpur Railway Company has placed an order for bridge-work in Japan. The contract sum is given as 91,367 rupees (about £6850).

LAST week, 1132 vessels, representing 939,690 net register tons, used the Port of London, 557 vessels being to and from colonial and foreign ports, and 575 vessels being engaged in constwise traffic.

REFINING of crude oil into benzine and other products will be started in the New Plymouth Oilfields, New Zealand, in October. A refinery company has agreed to purchase crude oil to the extent of 5,000,000 gallons.

THE Cunard liner "Carmania" is to be scrapped. She is of 19,000 tons and was built on the Clyde in 1905. It will be remembered that in 1914 she had a duel with another armed liner, the "Cap Trafalgar," and sank her.

THE programme arranged by the Association of Public Lighting Engineers for its eighth annual meeting and conference has now been issued. The period commences on September 6th with "arrival in Edinburgh," but the real business starts on Monday morning, September 7th, at 9.30 a.m., at Edinburgh University.

IT is expected that the dam of the Abitibi Canyon power station in Northern Ontario will be finished by February 1st of next year. It will be 250ft. high by 1000ft. long, and will provide 305,000 horse-power. In connection with this scheme a transmission line 260 miles long is being constructed to Copper Cliff for the transmission of 100,000 horse-power at 132,000 volts.

DURING July no fewer than 7675 British telephone subscribers who rang up the Continent used the "personal" call system. This is an increase of 3264, or nearly 100 per cent. over July last year, and of 1092 over June this year. Under the "personal" call system the telephone authorities find the person to whom it is desired to speak, or, if the person cannot be found, the subscriber is only charged a small fee.

A NEW gas plant of thirty vertical ovens, with a capacity of 3,000,000 cubic feet per day, which will also manufacture metallurgical coke as a by-product, will be built by the British Columbia Electric Railway Company at Vancouver. The plant will have a capacity of 180 tons of coal per day, and an annual consumption of 30,000 tons of British Columbia coal is estimated. The plant is to be completed by November 1st, 1932.

THE Republic Gas Corporation of America has started delivering gas from its reserves in the Hugoton field, South-West Kansas, to the Northern Natural Gas Company, which is serving cities of Eastern Nebraska and Central Iowa through its new 800-mile pipe line system. The new system is designed for a capacity of more than 160,000,000 cubic feet of gas a day and already represents an investment of 30,000,000 dollars.

THE probability of a new oilfield being opened up in Alberta is indicated by promising reports from the No. 1 well, of the Mayland Oil Company of Calgary, now being drilled in the Reserve field, some 45 miles east of Coutts. The gas was struck at the remarkably shallow depth of 1807ft., just on top of a black limestone, and the gas, which is stated to be wet with a strong odour of crude oil, is running at the rate of from three to five million cubic feet per day.

THE Department of Overseas Trade has despatched to the more distant countries overseas the first of three letters which are to be sent to 55,000 individual buyers, in over 100 countries, informing them of the arrangements for the British Industries Fair, which will open in London and Birmingham on February 22nd. Attention is also called to the different closing dates for the various sections of the Fair, as follows:—London: Olympia, March 3rd; White City, textiles, March 5th. Birmingham: Castle Bromwich, March 4th.

THE completion of a new high-level bridge, at a cost of 500,000 dollars, across the Fraser River, near Lillooet, British Columbia, on the line of the Pacific Great Eastern Railway, has enabled the railway to make an important change of route, and brings direct train service to the town for the first time in its history. The bridge and 5 miles of new road bed constituted a very important improvement programme for the provincial Government-owned railway tapping central British Columbia. Three great concrete piers carry the bridge structure at a height of 250ft. above the torrent of the Fraser.

NEGOTIATIONS which are now under way between the American Manganese Steel Company of Chicago, Ill., and J. B. Baillargeon, Industrial Commissioner of Montreal, may lead to the establishment of a foundry and plant in Montreal. "Unofficially, it is stated," says the *Montreal Gazette*, "that the company proposes to erect a 2,000,000-dollar plant in the eastern part of the city on the banks of the St. Lawrence River." The company will manufacture manganese steel castings, machinery and parts, and also heat and corrosion-resisting castings. In order to facilitate the unloading of the manganese ore, shipped from South Africa, a site on the St. Lawrence River will be selected.

THE GRAMPIAN HYDRO-ELECTRIC POWER SCHEME

BALFOUR, BEATTY AND CO., LTD., LONDON, ENGINEERS AND CONTRACTORS

(*For description see page 218*)

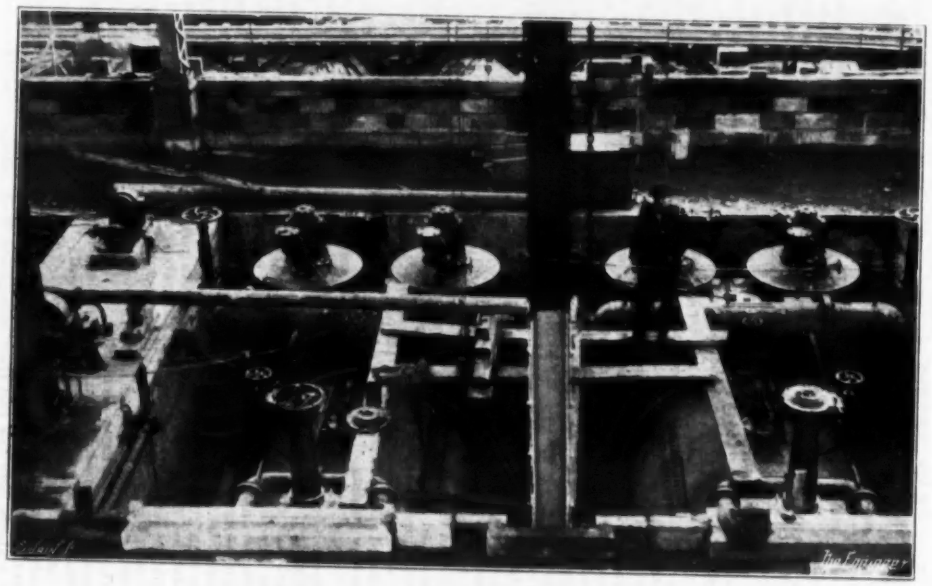

FIG. 33—VALVE HOUSE DURING CONSTRUCTION

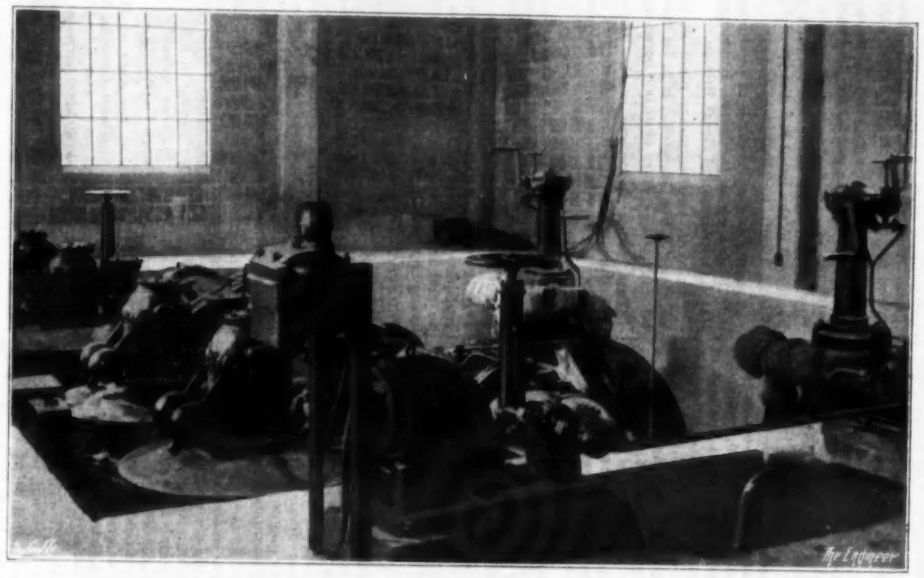

FIG. 34—VALVE HOUSE, SHOWING ANTI-VACUUM AND HAND-OPERATED VALVES

FIG. 35—VALVE HOUSE—GEAR FOR OPERATING AUTOMATIC VALVES

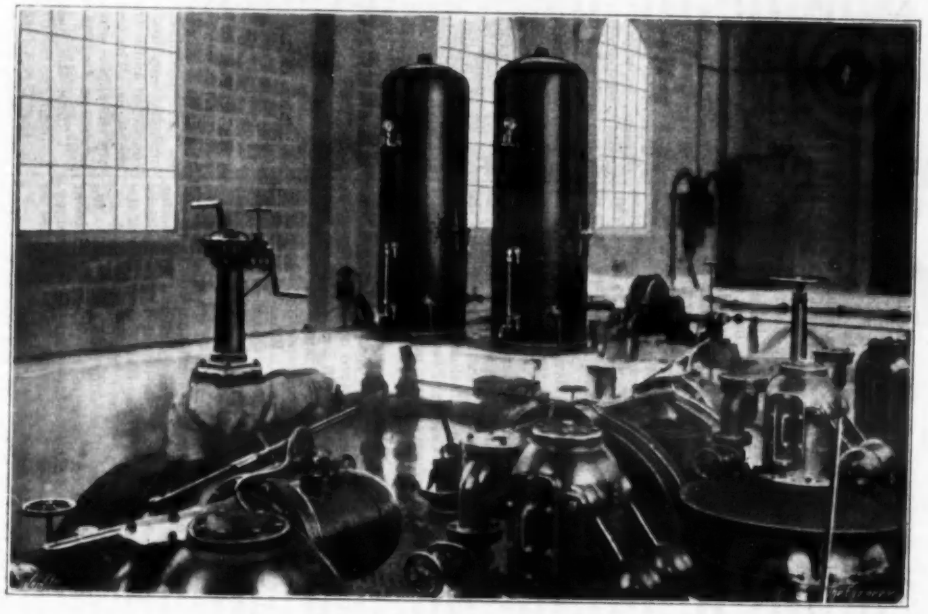

FIG. 36—VALVE HOUSE—GENERAL INTERIOR VIEW

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The Metallurgist.

THE AUGUST NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATH.

On August 26th, suddenly, at Walmer, STAFFORD RANSOME, M. Inst. C.E., of 65, Portsdown-road, London, W., Age 70.

THE ENGINEER.

VOL. CLII. No. 3946

AUGUST 28, 1931.

The Nature of Combustion

IN a recently published report* of the Aeronautical Research Committee some experiments are described which seem to throw fresh light on the nature of combustion. It was long suspected that a possible cause of the outbreak of fire in an aeroplane when it crashed was the ignition of petrol or oil by contact with the hot exhaust pipe. The subject was investigated and it was found that to ensure immunity from fire caused by petrol or oil flowing over the outside of a hot exhaust pipe the temperature of the pipe must not exceed 350 deg. Cent. That figure being more or less accepted, the question arose whether it would also apply if the petrol or oil found its way to the inside instead of the outside of the exhaust pipe. It is not our object to describe the experimental methods employed in the investigation of this question or to dwell upon the immediate answer to it which has now been provided; it is sufficient in passing to note that the general answer is that risk of fire exists if petrol or oil finds its way into the interior of an exhaust pipe at a temperature of 280 deg. Cent. or over. The features of the investigation to which general attention may be directed are the time lag before explosion and the temperature changes observed in the interior of a hot cylindrical vessel into which a quantity of petrol or oil or other combustible had been introduced. It is obvious that in these features we have subjects of wide general interest extending far beyond the narrow confines of the immediate research.

The explosion vessel was a welded steel cylinder closed at its ends and was preserved at any desired constant temperature by means of a jacket containing the vapour of mercury boiling under reduced pressure. A measured quantity of petrol or other combustible could be introduced from a pipette into the interior of the vessel through one of its ends. Various sizes of explosion vessel were employed, and it was found as a subsidiary feature of the investigation that the results were noticeably influenced by the dimensions of the vessel. We quote the results obtained with a cylinder 12in. in diameter and 12in. high, and will give as typical those recorded when the combustible was aviation spirit. With a mixture strength of 1·7 per cent. by volume explosion occurred 60 seconds after the fuel was introduced into the vessel when the vessel was at a temperature of 265 deg. Cent. At lower temperatures of the vessel the period of lag before explosion occurred increased. At 249 deg. Cent., for example, the lag period amounted to 180 seconds. When the vessel had a temperature of 243 deg. or less no explosion took place. Various other mixture strengths were tried. The richest contained 4·2 per cent. by volume. At this strength a lag of 60 seconds before explosion again occurred when the vessel was at a temperature of 265 deg. At lower temperatures, as before, the lag increased until at 235 deg. it amounted to 680 seconds. At only one degree less, 234 deg., no explosion occurred. It is natural to inquire what was happening inside the explosion vessel during the period of lag. Some light is shed on this subject by the observations which were made of the temperature as recorded by a thermo-couple placed at the centre of the explosion vessel interior. It was found that in all cases the immediate effect of the introduction of the combustible fluid was to cause a fall in the temperature, followed—after an interval in some cases of ten minutes or more—by a rapid rise just before explosion took place. The initial fall of temperature, it might be supposed, would be caused by the introduction of the cold liquid into the vessel and its subsequent evaporation. To test this point a quantity of water requiring the same amount of heat for its vaporisation was introduced in place of the combustible. No measurable change of temperature was observed. As an additional test the combustible was introduced into the vessel when it was filled with carbon dioxide instead of air. Again no measurable change of temperature was noted. The initial fall of temperature is therefore to be ascribed, apparently, to some feature of the combustion process. In those cases in which no explosion occurred there was, as before, at the outset a fall of temperature. Then for some minutes afterwards there would be a rise, at first slow and finally rapid, to a sharply marked maximum which might reach as high a value as 40 deg. above the temperature of the vessel. Thereafter the temperature would fall, not smoothly, but in distinct waves. No analysis is given of the contents of the vessel after each test. We are left to infer that the combustion of the fuel was complete both in the tests which give an explosion and in those which gave no explosion.

The author of the report, Mr. W. G. Glendinning, is cautious in interpreting these results. His apparatus was not designed specifically for the purpose of investigating the time lag or the change of temperature. In addition, as he points out, the temperature change was measured at only one point, the centre of the explosion vessel, and therefore it would be unwise to depend upon it as being representative of the general temperature change throughout the interior of the vessel. An isolated experiment with the thermo-couple midway between the centre and the side of the vessel showed a somewhat different type of temperature change, although it was still marked by an initial fall during the first two or three minutes. The only speculation which Mr. Glendinning permits himself to make is that during the early stages the lowering of the temperature is probably to be accounted for mainly by some endothermic reaction which for a time preponderates over the exothermic reactions of the combustion. This suggestion is of much interest. It supports the view which we ourselves advanced in October, 1925, to the effect that combustion may not always and at all temperatures be an exothermic reaction and that it is conceivable that under certain circumstances it may proceed without the evolution of heat and even with the absorption of heat. Chemically regarded, combustion is merely a process of oxidation and only use and wont have led us to regard it as being necessarily associated with the liberation of heat. Six years ago we advanced the suggestion that heatless combustion might be a possibility and as such an explanation of certain phenomena as, for example, that of the missing temperature and pressure in internal combustion engines. The suggestion was debated at length in our columns by several well-known

* R. and M. No. 1375, "Possible Cause of Aircraft Fires on Crash," H.M. Stationery Office, 1s. net.

authorities on combustion, but on the whole, while its novelty appealed to some, it was not generally accepted as being a physical possibility. Reasons which, it must be admitted, still carry weight were advanced against it. In view, however, of Mr. Glendinning's results, further attention to the subject seems to be justified.

Automatic Sub-stations.

One of the results of electrifying British main line railways at the proposed D.C. pressure of 1500 volts would be the creation of a big demand for automatic sub-station equipments. The ingenious people who designed and developed them would then have the satisfaction of knowing that in some measure—and in a greater measure than many might suppose—they had helped to oust the steam locomotive from the long-distance lines of this country, where, in view of the scarcity of water power and adequate supplies of coal, there is much less justification for electrification than there is in many other parts of the world. Having apparently decided that 1500 volts would be ample for the purpose, the electric traction experts would take full advantage of every known device for reducing working expenses. When sub-stations had to be manually operated on the spot, attendants' wages were a distinct drawback to the D.C. system, but now that they can look after themselves many consider D.C. traction to be devoid of any serious disadvantage. While for general and industrial and domestic purposes D.C. is giving place to A.C., no such change is deemed to be desirable in this country in connection with electric trains, even if they have to travel long distances. Since the advent of automatic switching, the case for D.C. traction has been strengthened because it eliminates, or at any rate greatly reduces, labour and minimises power losses by limiting machine operation to periods when the load justifies it. The automatic starting of plant, which is, of course, applicable to other classes of service, may be arranged for in various ways. In some cases it is possible to make it dependent on voltage drop, giving with re-closing circuit breakers, &c., fully automatic working. Again, under certain conditions, it may be made to depend on a time switch, as in the case of the Eastcote sub-station on the Metropolitan line, but far more frequently it depends, in the case of such railways, on remote control. Automatic and remote control may be, and frequently are, combined. Often the distant gear closes the transformer switch, thus starting the rotary which synchronises itself and connects itself to the D.C. bars. By means of the supervisory system, the controls for a number of sub-stations can be terminated at a common point and be operated by one attendant, who, by means of indicators, &c., can see at a glance the conditions existing in the sub-stations. The feeder circuit breakers, &c., may also be under remote control, which does various other things. Unattended sub-stations are automatically protected against faults, and automatic load limiting devices, used mainly, we believe, in America, make possible the maintenance of power on the bus-bars during overload conditions which would otherwise necessitate disconnecting the sub-station.

For the ingenuity that has been brought to bear on the design of fully automatic and semi-automatic sub-stations no one can fail to have admiration. Complicated and puzzling as the wiring diagrams of some automatic equipments are, the apparatus does the job, and it does it very perfectly. But the main point is that it pays. The importance of the automatic sub-station from the point of view of railway economics arises from the fact that the wages in the average manually operated sub-station amount to about £1200 a year. If the sub-station becomes automatic, Mr. Roger Smith has stated, about £200 a year may be spent on its inspection, leaving a saving of about £1000, which capitalised at 10 per cent. is £10,000, or at 8 per cent. £12,500. For the average railway sub-station containing two 2000-kW rotary converters the added cost of making the plant automatic is about £2500, and if remote control be added from £3000 to £3500. Thus, according to whether the capital charges are reckoned at 10 per cent. or 8 per cent., something like £7000 to £9000 is saved per sub-station by the use of automatic equipments. This, Mr. Smith has explained, entirely alters the economics of the use of low-tension current for railway electrification, because if that amount of money can be saved on the sub-stations, it may be permissible to put them closer together, and so use a lower track voltage than would otherwise be desirable. Here we probably have the explanation, or at any rate one explanation, as to why it has been found to be permissible to electrify the Brighton line at 600 volts. Automatic control is also claimed by those who make the equipment to permit of the use of more sub-stations for general electricity supply in areas where D.C. distribution is employed, the object being to avoid the use of long and expensive low-tension cables. But desirable as automatic control may often be, it is to be hoped that it will not encourage engineers to perpetuate D.C. distribution if it can possibly be avoided. The question to be settled may not be whether sub-stations should be manually or automatically operated, but whether converter or rectifier sub-stations are necessary at all. As Messrs. Beard and Haldane pointed out in a paper read before the Institution of Electrical Engineers in 1927, A.C. now meets the needs of consumers just as well, if not better, than D.C., except for a very few special types of motor drives, which can always be dealt with by local conversion. An investigation made by the authors showed that according to the load the expensive converting plant may increase the distribution costs from 20 to 40 per cent. as compared with those of the A.C. system, even after making full allowance for the saving in labour due to the modern automatically operated sub-station. Again, in his address delivered before the Engineering Section of the British Association in 1926, Sir John Snell explained that the cost of machinery—apparently manually operated—for a converting sub-station was some eight times greater than that of static transformer sub-stations. Millions of pounds are being spent in this country on the standardisation of frequency in order that all generating stations may produce precisely the same kind of current, and it is clearly desirable that this current should be sold to consumers.

For the operation of main line railways, engineers are still to be found who advocate the single-phase system working at low frequency. According to a recent article by Sir Philip Dawson, after years of experimental work with both systems, the Pennsylvania Railroad has definitely adopted A.C. for all its lines between New York and Washington and New York and Harrisburg, the most important main line scheme ever carried out. Norway, Sweden, Germany, Switzerland, and Austria have also chosen the system for their main lines; whilst the French engineer, Monsieur Parodi, who is responsible for the 1500-volt D.C. electrification of the Orleans railway and the 3000-volt D.C. Morocco railway, is said to have stated that if he had to start now he would favour A.C. To some, however, the Kando system is now probably more attractive than the ordinary low-frequency system. After seven years of experimental work, it is being put to the test of practical application in Hungary, where maximum economy is being aimed at. From a single overhead wire the standard 50-cycle current is to be drawn at 16,000 volts; the efficient and cheap outdoor sub-stations will be spaced at relatively great distances, and much of the paraphernalia associated with D.C. traction distribution will be eliminated. On the other hand, the locomotives would appear to be somewhat complicated, and we imagine expensive. Nevertheless, the scheme can scarcely fail to interest engineers who are ready to set aside old ideas and to consider the merits of any new method which aims at reducing the total constructional and working expenses.

Rand Water Board—Annual Report.

As usual, the Annual Report of the Chief Engineer to the Rand Water Board—Mr. C. E. Mason, M.I.E.E., M.I. Mech. E.—contains a great deal that is of interest. The present report, which has recently reached us, deals with the year ended March 31st, 1931, and is the twenty-sixth of its series. Accompanying it is a plan showing the extent of the Board's operations, and as we have not previously given a plan which embraces the whole of the Board's activities, we take this opportunity of reproducing it in the accompanying engraving, since it will enable our readers the better to understand the contents of the report, of which we propose, following our usual custom, to give a summary in what follows.

It may be explained, at the outset, that the estimated population within the limits of supply during the year under review amounted to a total of 674,886 persons, made up of 287,412 Europeans and 387,474 non-Europeans. The Board's systems of supply, comprise, as our readers are aware, the Vaal River impounding reservoir, two sets of bore-holes in the Klip River Valley to the south, and to the west of Zwartkopjes Main Pumping Station, and wells at the Zuurbekom Pumping Station. The total quantity of water raised during the year was 6,447,311,700 gallons, which represented an increase of 556,000,000 gallons over that raised during the previous year. Of the total quantity 58·29 per cent. was taken from the Vaal River, 30·15 per cent. from the Zuurbekom wells, and the balance of 11·56 per cent. from the Zwartkopjes bore-holes. The percentage of the loss by leakage to the water pumped was 1·455, which showed a decrease of 0·439 per cent., as compared with the previous year's figure. It is explained that, included under the heading "leakage" is the water used in cleaning reservoirs and in scouring mains, loss from evaporation and water unaccounted for.

The net quantity of water available for distribution was 20,000,000 gallons per day, that figure being made up of 10,600,000 gallons from the Vaal River and 10,000,000 from Zwartkopjes and Zuurbekom, a total of 20,600,000 less leakage, wastage, &c., 600,000 gallons. The quantity of water sold during the year was 6,255,894,924 gallons, as compared with 5,674,088,295 gallons in the previous year, or an increase of 581,806,629 gallons.

Particulars are given in a graph of the water consumption in various directions. The total demand from all sources shows a continuous upward tendency. The total consumption of the municipalities showed a sharp increase after the slight falling off which had been experienced during the preceding year. It is difficult, the Report explains, to say to what extent that increase may be attributed to the influence of rainfall conditions. Thus, during the year 1929, the total annual rainfall recorded was 36·70in., as compared with 25·62in. recorded for the year under review, the average for the last forty-two years being 32·95in. The number of days on which rain falls during the summer months has probably more effect on municipal consumptions than has the total annual rainfall. In this connection, it is noteworthy that during August and September rain was only recorded on two days, and during October, on seven days, while during November, December, January and February rain was recorded nearly every day. It would appear, therefore, it is remarked, that the increased consumptions may, in a general way, be attributed to the general expansion and demand throughout the area supplied. The consumption by the mines showed a sharp upward tendency, the quantity of ore milled having increased by 1·053 million tons for the year. The total consumption by the railways, on the other hand, showed a slight fall.

The water pumped from the Vaal River is filtered and chlorinated at Vereeniging before being pumped to Zwartkopjes, where it mixes with water from other sources, the mixed water being again chlorinated at Zwartkopjes. The water from the Zuurbekom wells is pumped directly into supply. At each source, and at numerous points on the distribution network, the water is subjected to frequent chemical and bacteriological examinations. Three hundred and six chemical, and five hundred and eleven bacteriological examinations, were made during the year, and the quality of the water was found to be consistently good throughout the whole period.

The rainfall of 25·62in. was the lowest recorded for ten years. The winter—April-September—rainfall was 3·04in., or 11·9 per cent. of the total, and the summer rainfall 22·58in., or 88·1 per cent. of the total.

The Board's storage reservoirs are situated at the pumping stations, and all high points along the Witwatersrand. They are referred to in the Report as "storage" reservoirs, but they are really more in the nature of service reservoirs, as they serve the purpose primarily of facilitating the distribution of water and do not provide storage accommodation beyond assisting in meeting peak demands over short periods. The particulars of these reservoirs are as follows:—

Reservoir.	Capacity. Million gallons.
Zwartkopjes	12,500
Vereeniging	5,000
Krugersdorp	1,389
Paarlshoop	0,530
Forest Hill	5,000
Signal Hill	2,500
Benoni	2,500
Leeuwpoort	1,268
Total	30,687

The Leeuwpoort Reservoir, which had been out of commission for some years past, was brought into service again during the year, following on the installation of a pumping station at the reservoir.

In addition to the reservoirs mentioned above, the municipality of Johannesburg owns reservoirs at Brixton, 1·268 million gallons; Berea, 0·960 million gallons; Yeoville (old), 3·906 million gallons; and Yeoville (new), 10·239 million gallons, which are supplied with water by the Board.

The Board's reticulation system extends from Randfontein to Springs and is served by pumping mains from Zwartkopjes to the East and Central Rand and from Zuurbekom to the West and Central Rand. There are in service 286 miles of pipe lines, composed of 262 miles of pumping and gravitation mains and 24 miles of collecting mains from bore-holes and wells. These pipe lines consist principally of welded and riveted steel pipe, but in recent years extended use has been made of reinforced concrete

pipes manufactured locally. Some wrought iron pipes, it may be mentioned in passing, which were put into service in the Zuurbekom area in 1898—just prior to the Boer War—are still working satisfactorily. The largest diameter pipes in service are 36in. in internal diameter.

As a precautionary measure against damage by lightning the electrical plants and machinery at the Zwartkopjes and Zuurbekom pumping stations were shut down on a number of occasions during severe thunderstorms. The following table shows the number of times when it was found necessary to shut down the different sections of the plant, the number of times when damage occurred, and the hours during which current was cut off :—

	Zwartkopjes borehole lines.		Zuurbekom lines.
	Western section.	Southern section.	
Times shut down	47	45	23
Occasions when damage was done	Nil	1	13
Hours during which current was shut off	148	87	80

The total cost of repairing the damage done to plant only amounted to £55 7s. 8d.

We have on previous occasions remarked on the fortunate position in which the Board has hitherto found itself as regards the price it has paid for its coal. In the early part of the year under review, however, one contract by which it received its supplies terminated, and it had to call for further tenders. As a result, only one tender was received, that from the Transvaal Coal Owners' Association, which was limited to a period of three years as from July 1st, 1930. By the terms of this new contract the Board is obliged to take at least 30,000 tons of coal per annum for its Zwartkopjes pumping station from Coalbrook Colliery, which is in the Orange Free State, and of the balance of its requirements, approximately 28,500 tons, from selected collieries in the Witbank District in the Transvaal. The coal supplied from Coalbrook will be similar in quality as that supplied under the last contract, but whereas the cost of transport will remain the same at 4s. 7d. per ton, the cost per ton delivered has been raised from 6s. 1d. to 8s., a difference of 1s. 11d. per ton. The basic price of the coal supplied from the Witbank District is 11s. 6d.

During the year under review 59,369 tons of coal were delivered at the Board's railway sidings for use at Zwartkopjes pumping station at an average price of 9s. 0·096d. per ton—or a total of £26,740. Of the total, 13,716 tons were delivered from Coalbrook, under the old contract, at an average price—after correction for calorific value—of 6s. 1·824d. Of the balance, 23,992 tons were delivered from Coalbrook under the new contract at an average price of 8s. 1·358d. per ton, and 21,244 tons from the Witbank District at an average price of 11s. 9·985d. per ton. The balance of 417 tons was made up of test coal at an average price of 10s. 6·72d. per ton. The guaranteed calorific value of Coalbrook "nuts" is 9·8 and from Witbank 12·3.

The comparative cost of coal consumed at the Zwartkopjes pumping station for the last two years was as follows :—

Year.	Coal consumed, tons.	Average price per ton.	Total.
1930	61,340 ..	6s. 0·794d. ..	£18,605
1931	59,732 ..	9s. 0·096d. ..	£26,903
	Increase ..	2s. 11·302d. ..	£8,298

The total tonnage of steam coal delivered to all pumping stations during the year under review was 80,365 tons, as compared with 80,653 tons delivered during the previous year. The decrease is put down to the use of a certain quantity of higher calorific value coal from the Witbank District.

The total cost of coal delivered during the year at the railway stations and sidings serving the various pumping stations was £33,727, which was £8816 more than was paid the year before. The average price paid for all coal delivered at these railway stations and sidings was 8s. 4·72d. per ton, as compared with 6s. 2·12d. per ton during the previous year, the increase being 2s. 2·60d. per ton. The cost of transport of the coal from railway stations and haulage over sidings to the various pumping stations was £2006, or 5·99d. per ton, as compared with £1949, or 5·80d. per ton, to the previous year. The total cost of the coal delivered at the coal bunkers was, therefore, £35,733, as compared with £26,860 for the previous year. This gave an average of 8s. 10·71d. per ton, as compared with 6s. 7·92d., an increase of 2s. 2·79d. per ton.

As regards operating costs, at the Vereeniging Pumping Station, the coal for which is obtained from another source and remained unchanged in price, the cost of pumping only—1000 gallons of water raised 100ft.—fell from 0·1860d. to 0·1787d., for the first six months, and from 0·1750d. to 0·1697d. for the second six months. At the Zwartkopjes Station the increased cost of coal was, of course, reflected in the increased pumping costs. As the new coal contract only came into operation during the middle of the first six monthly period, the increased cost during that period is not so large as that shown in the second six months, when the full influence of the increase was felt. The unit cost for the first six months showed an increase from 0·1200d. to 0·1278d., while for the second six months the increase was from 0·1260d. to 0·1417d. At the Zuurbekom Pumping Station the unit cost decreased for the first six months from 0·3510d. to 0·3228d., and for the second six months from 0·3540d. to 0·3310d. According to the Report, these decreases were due to the greatly increased quantity of water raised, which reduced the unit costs to such an extent that the increased costs due to coal were more than counteracted. At the Paarlshoop Pumping Station the unit costs for the first six months fell from 1·2940d. to 1·1071d., and for the second six months from 0·9370d. to 0·4848d. These decreases were also due to the increased quantity of water pumped. The cost of pumping only—1000 gallons raised 100ft.—over all the pumping stations was 0·1758d., as against 0·1759d. for the previous year, the increased cost of the coal being counterbalanced by the effect of the reduction which would have resulted from the increased quantity of water pumped. The total cost, including purification, based on the quantity of water sold, was 6·4040d. per 1000 gallons, as compared with 6·352d. for the previous year.

The main centrifugal pumps at Zwartkopjes are four in number, and each is capable of raising 5½ million gallons of water per day against a head of 1200ft. To improve the suction arrangements, a low-lift pump, capable of dealing with 15 million gallons of water per day against a head of 35ft., is being installed to supply water to the high-lift pumps. It is expected that the improved conditions will result in a saving both in coal and maintenance costs. Improvements were also effected in the boiler feed arrangements, while an additional air and condensate pump for the Parsons steam turbo-centrifugal pump is being erected.

At the Vereeniging Pumping Station the new protective works, consisting of pre-sedimentation tanks and water-cooling sprays, which were described in the last report, were completed and put into service, the pre-sedimentation basins having been in continuous use. During the first six months of the year an average of 10·016 million gallons was pumped per day from the Vereeniging Reservoir, and an average of 9·801 million gallons per day was sent into service. During the second six months, an average of 10·579 million gallons a day was pumped from the reservoir, and an average of 10·327 million gallons a day was sent into service.

The Zuurbekom Pumping Station draws its water from wells and bore-holes. The water is of a high degree of purity, and it is pumped into supply without treatment, a portion being gravitated to augment the supply at the Zwartkopjes Station. During the year, the station dealt with 1944 million gallons, or about 30 per cent. of the total supply. The main pumps are driven by electricity generated at the Zwartkopjes Station. The pumping plant at the Paarlshoop Station operates during periods of high demand in conjunction with the low-lift pumps at Zuurbekom, and also facilitates the distribution of water from the Forest Hill Reservoir. Its plant is driven by electric power supplied by the Johannesburg Municipality. During the first six months of the year the station pumped 78,651,000 and during the second six months 282,234,000 galloms.

The Board possesses two booster stations, one at Leeuwpoort Reservoir and the other at Knight Central. The former, which was installed in 1929, is for the purpose of maintaining the water pressure in the Springs and Far East Rand area, and it also makes the Leeuwpoort Reservoir available for additional storage. The plant is operated by energy obtained from the Victoria Falls and Transvaal Power Company, Ltd. The Knight Central Station, which is situated on the east side of Germiston, assists in maintaining pressure, either to the east or west of the station during periods of high demand or breakdown of plant. It also is operated by energy obtained from the Victoria Falls Company.

The total discharge of the Vaal River at the Barrage during the year amounted to 181,000 million gallons, as compared with 829,330 million gallons during the previous year—April to March. The lesser flow would have been sufficient to fill the Board's reservoir, which has a capacity of 13,633 million gallons, thirteen times, as compared with sixty-one times the previous year.

AREA COVERED BY THE RAND WATER BOARD'S OPERATIONS

BOOKS RECEIVED.

The British Empire in 1950. By G. Moores, F.T.I. London: John Heywood, Ltd., 20–22, Bride-street, E.C. 4. Price 2s. 6d. net.

Annales des Ponts et Chaussées. 1931. Fasc. III., Mai-Juin. (1) *Partie Administrative*, (2) *Partie Technique*. Paris: 5, Rue Jules Lefebre.

The Romance of Electricity. By W. L. Randell. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E. 1. Price 10s. 6d. net.

Quartz Resonators and Oscillators. By P. Vigoureux, B.Sc. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 7s. 6d. net.

Locks and Lockmaking. Second edition. By F. J. Butler. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 3s. net.

The British Waterworks Year Book and Directory, with Statistical Tables, 1931. Third edition. Edited by G. P. Warner Terry. London: The British Waterworks Association, 173, Rosebery-avenue, E.C. 1. Price £1 1s. net.

The New Matriculation Light. Second edition. By R. W. Stewart, D.Sc. Revised by R. W. Hutchinson, M.Sc. London: University Tutorial Press, Ltd., High-street, New Oxford-street, W.C. Price 3s. 6d. net.

Metal-clad Switchgear.

Modern power-house and sub-station switchgear bears little resemblance to that in use in bygone days, when the amount of power that had to be handled was relatively small. Some idea of the nature of the work involved in the production of present-day high-capacity switchgear can be gathered from Fig. 1, which shows the main castings of a 1,000,000-kVA metal-clad draw-out pillar, manufactured by the English Electric Company. These units are being supplied for current-carrying capacities up to 3000 ampères, with bus-bars designed for 4000 ampères. Duplicate bus-bars are provided, and the process of changing over from one set to the other is effected by means of oil-immersed selectors in the large upright aluminium castings shown above the top plate. The

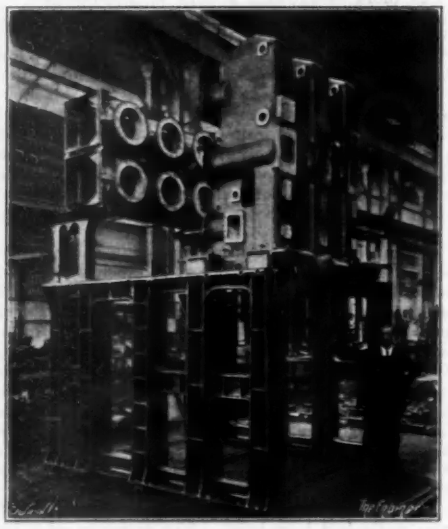


Fig. 1—1,000,000 kVA Rupturing Capacity Metal-clad Unit Partly Assembled

single piece castings are said to be the largest of their kind produced in this country, and it is interesting to note that the unit complete weighs 16 tons, and the moving portion alone 6½ tons. Each unit is electrically operated on the remote-control system, and from a separate control room, by means of a solenoid.

The lines on which the English Electric metal-clad units are constructed will be understood from the sectional drawing—Fig. 4—which shows a unit with duplicate bus-bars and on-load selector switch, the movable carriage being shown withdrawn. The letters A to M refer to the following parts:—A, expansion domes to prevent leakage of compound; B, bus-bars insulated for the system voltage; C, automatic dust-tight and vermin-proof shutters; D, current transformer chamber, oil or compound filled; E, three current transformers; F, oil-immersed potential transformer; G, oil-immersed change-over selector switch; H, fan-shaped blade for changing over under load; K, patented vent system; L, trip-free operating gear; M, heavy boiler plate tank to withstand internal pressure.

The illustration—Fig. 2—shows the hollow high conductivity 4000-ampère bus-bars that are used in these units, each bar having 16 square inches of copper. A bus-bar assembled in one of the bus-bar chambers is shown in Fig. 3, whilst Fig. 5 shows part of the control board for controlling the units shown in Fig. 1. This switchboard is of cubicle type, and as assembled on site it forms the three sides of a square. A semi-circular desk switchboard—not shown in the illustration—also forms part of the equipment and contains the whole of the generator controls, the incoming feeder controls, signalling equipment and engine-room telegraphs.

Metal-clad insulation-filled switchgear is now widely used in power stations and sub-stations. There are, however, engineers who still prefer "non-filled" types, in which it is possible to obtain access to the whole of the component parts, and the English Electric Company has devoted attention to this class of gear for many years. The chief advantages of the filled type are (*a*) better utilisation of space, (*b*) ease of interlocking and rendering foolproof, and (*c*) a completely dead exterior. No fewer than sixteen features are claimed for the English Electric compound-filled gear, namely:—(1) Dust, vermin, and moisture are definitely excluded under all conditions by dustproof shutters. (2) Leakage of compound is prevented by expansion domes. (3) Multiple-vent pipes prevent oil-throwing and siphon action. (4) Current transformer chambers can be filled with solid compound or oil, which facilitates changing transformers. (5) In all sizes of the gear, with the exception of the smaller, three current transformers per phase can be accommodated, whilst the smaller size will accommodate two. (6) For duplicate bus-bars, selector switches, or plug changing is standard. (7) The tape-wrapped bus-bars and connections are insulated for full voltage. (8) Small wiring contacts are of the knife-switch type, which are claimed to be more reliable than the plug-and-socket type. (9) An inspection test-box is provided for testing trips, closing coils, &c., with the circuit breaker isolated. (10) All parts that need adjustment are on the movable part of the unit. (11) Locking pins are provided for the in "service," "test," and "fully out" positions. (12) Interchangeability of the parts is ensured by the employment of special jigs and tools. (13) All castings are sand-blasted to remove scale. (14) Copper castings are made by a special process; they are 99·6 per cent. copper, and their conductivity is higher than that of ordinary castings. (15) Individual parts, each sub-assembly and final assembly, are tested and inspected while in the shops; and (16) compound filling is carried out at the works with the aid of special ovens and appliances which ensure the absence of air pockets.

The English Electric metal-clad switchgear covers a comprehensive range of rupturing capacities and voltages, and in all sizes many variations are available, as, for example, in the method of operation of the circuit breaker and in the means of bus-bar selection. Up to and including one million kVA rupturing capacity, the method of isolation is on the well-known horizontal draw-out principle, which has the advantage over the vertical drop-down arrangement that the bus-bars are kept away from the oil circuit breaker. For units having a rupturing capacity of 1½ million kVA and above, the weight and other features of the movable portion are beyond the capabilities of the draw-out design, and the vertical method of isolation is therefore adopted for these large units, but measures are taken to remove the bus-bars from the danger zone of the circuit breaker. The fixed portion of a metal-clad switching unit comprises the bus-bars instrument, transformers and main frames, and the moving portion, the oil circuit breaker, and its operating mechanism. The sets of single or duplicate bus-bars are enclosed in metal chambers filled with solid insulating compound, which is put in the chambers before despatch, and they are supported by insulators of high dielectric and mechanical strength, fully capable of withstanding short-circuit stresses and the temperatures which occur during the process of filling with compound in the melted state. The bus-bars themselves and the connections from them to the spouts or outlets from the enclosing chambers consist of laminated copper, which is adequately wrapped throughout its length with insulating tape to withstand the normal voltage of the system. The supporting insulators have a high factor of safety above the test pressure applied to the complete unit.

When the bus-bar chambers are dispatched from the works the opening into which the compound is poured is covered by a transparent plate, which is removed after erection on site and is replaced by an expansion dome, so that free expansion of the compound can take place when heating occurs owing to heavy overloads or climatic conditions. The scheme obviates the possibility of the compound being forced out from the joints and the consequent formation of cavities when cooling takes place, whilst it also avoids the possibility of mechanical stresses in the spouts, supporting insulators and covers. For the purpose of coupling adjacent units together by means of connections designed to allow for expansion, the bus-bars project a short distance beyond the ends of each containing chamber, and when the complete switchboard has been erected the junctions are covered by jointing muffs, whilst the bus-bar projections of the end units of the board are enclosed by a cover, the muffs and covers being filled with compound. If an extension of an existing board is to be installed, all that is necessary for coupling it up is to remove the end cover and to substitute a coupling muff. When duplicate sets of bus-bars are required, two exactly similar bus-bar chambers are mounted one above the other and suitable means are provided for connecting the circuit to either set of bars. Three cylindrical spouts are bolted to the front of each bus-bar chamber to house the main isolating sockets, which are deeply recessed into insulating bushings and connected to the respective bus-bars by laminated copper strip. The contacts are of the self-aligning type and are liberally dimensioned for the currents to be carried. For currents up to 400 ampères a cylindrical design is adopted, whilst for higher currents the contacts are of the laminated strip type.

When the moving portion carrying the oil circuit breaker is withdrawn all the isolating contacts on the fixed portion are automatically covered by dust-tight shutters, which protect the contacts and prevent the settlement of dust at the bottom of the spout insulator, where it might eventually form a conducting path to earth. These automatic shutters have a felt lining and the actuating mechanism contains a cam device which pulls the shutter tightly on the spout

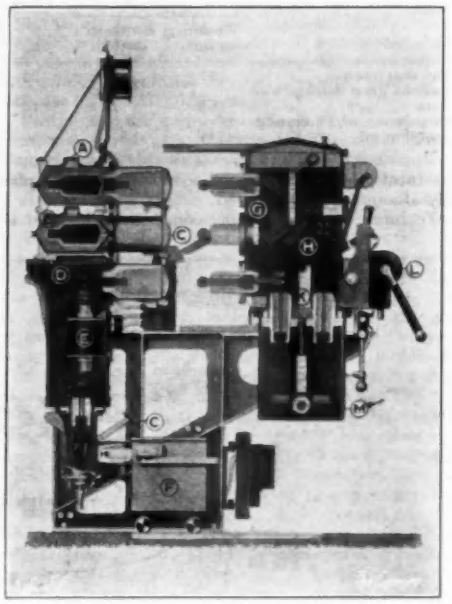


Fig. 4—Typical Section through Metal-clad Unit

face, thereby compressing the felt slightly and forming a dust and moisture-proof protection. The spout is also rendered vermin-proof, a matter of importance in tropical countries. The shutters can be locked in the closed position by means of padlock plates, thus ensuring definite protection to men working on the cables against the possibility of the circuit being accidentally connected to the bus-bars. Normally the current transformer chambers are mounted below the bus-bars and are provided with a set of three outlet spouts, together with isolating sockets for disconnecting the oil circuit breaker on the feeder side. The necessity for making adequate provision for increase of load and the desire for more accurate metering have led to more frequent changing of current transformers than in the past, and as a result the transformer chambers are designed so that they can be filled with oil instead of compound. When oil is used special care is taken to make the vertical joint oil-tight by fitting "Langite" packing, and severe tests are made to ensure that there is no leakage. When a potential transformer is fitted it is mounted on rollers in front of the cable box chamber and plugged into contacts on the cable box, or, when necessary, on a specially designed chamber. As it can be plugged in and out whilst the pillar is in service, the fuses can be changed without opening the main circuit. The transformer is oil filled and the fuses and limiting resistances are also immersed in oil. As an alternative the fuses may be of the limiting resistance type, but in both cases they are fully capable of giving protection against any fault which may occur in the transformer. Dust-proof shutters resembling those used for the main isolating contacts automatically cover the spouts containing the connections when the transformer is withdrawn. The cable dividing boxes are mounted

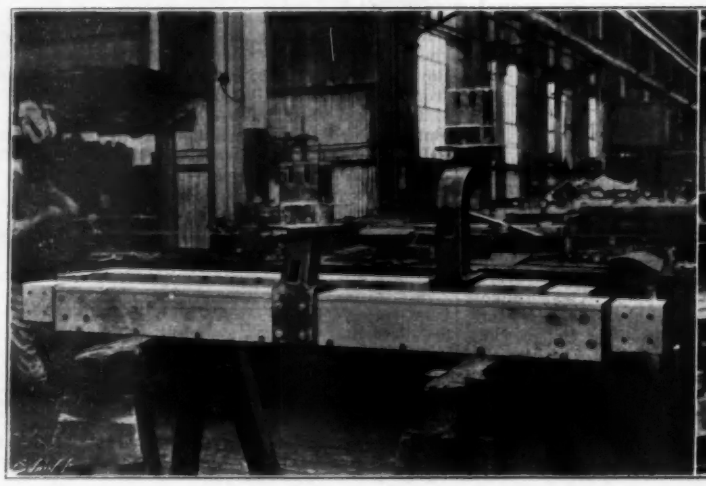


Fig. 2—Bus-Bars for 1,000,000 kVA Rupturing Capacity Unit

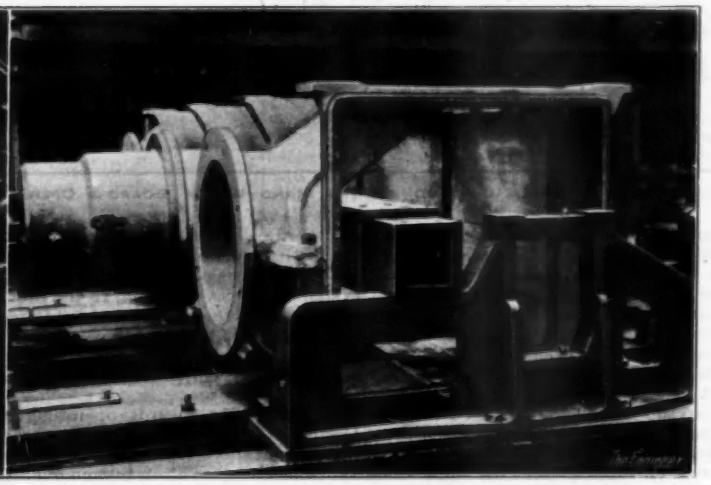


Fig. 3—Bus-Bar for 1,000,000 kVA Rupturing Capacity Unit Assembled in Chambers

immediately underneath the current transformer chambers and are arranged for filling with compound in the usual way, but special boxes suitable for oil filling can be fitted on 33-kV gear when desired. The boxes are split vertically and have ample space for making the internal connections, and they can be designed to suit any standard type of cable.

The oil circuit breaker consists of a heavy steel top plate which carries the three phases of the oil circuit breaker and the oil tank or tanks. Up to 750,000 kVA rupturing capacity one tank is employed for the three phases, but above this rupturing capacity three separate tanks are used. The breaker is operated by a simple arrangement of levers, and oil dashpots are used to cushion the shock on the opening stroke. The self-aligning contact fingers with heavy sparking contacts have a large volume of metal at the point where arcing takes place. There are two breaks in series and a high speed of opening is ensured by powerful push-off springs. The contact bar is wedge-shaped with a wide angle, which facilitates entry into the contact fingers and gives a high contact pressure while maintaining ease of closing.

The patented system of vents includes a baffle expansion chamber into which any gases produced on operation of the circuit breaker are forced. Baffle plates in which there are a large number of small holes are fitted inside the top of the breaker over each break. A small air space is provided above the oil as a cushion for the opening shock, and this air space communicates through the baffle plates with separate expansion chambers, from which vent pipes lead to the open air. The advantages claimed for the arrangement are: (*a*) very little oil is exposed to the air; (*b*) the baffle plates are situated at the source of pressure instead of at the end of the vent pipe; (*c*) in passing through the baffle plates the gases are cooled and the oil loses its velocity and is separated from the gases, with the result that the gas passes freely into the open through the vent pipes, but the oil remains in the expansion chamber and drains back to the tank; (*d*) vent pipes of small size are sufficient, since the baffles are at the source of the pressure instead of at the exit; and (*e*) multiple vent pipes prevent the possibility of syphon action. Normally the outer pipes are taken over the bus-bar chambers and discharge into the switch room, but when desired arrangements can be made for leading the vent pipes outside the building. The rectangular oil circuit breaker tank is constructed of steel plate of ample strength, and when all three phases are accommodated in one tank phase divisions are welded to the tank sides, the tank lining being spaced away from the walls of the tank, so that there is a layer of quiescent oil between the lining and the tank. The bolts which secure the tank to the top plate are arranged so as to be accessible in the event of the tank having to be removed, and they have self-locking nuts.

For units having a capacity not exceeding 500,000 kVA the circuit breaker operating gear may be of the manual or electrical type. Electrical operation is recommended for units exceeding 350,000 kVA capacity. It is invariably fitted on units of larger capacity than 500,000 kVA, and the operation can be effected either by a D.C. solenoid or a D.C. or A.C. motor. For use under emergency conditions or for inspection purposes, electrically operated circuit breakers are provided with an arrangement for closing the breaker by hand. In the case of the heaviest breakers a hydraulic jack is provided for this purpose, and the switch can be closed slowly, be left in any intermediate position, or it may be opened slowly. As the circuit breaker can be set in any desired position, the inspection of the contacts can be carried out by one man, and it is unnecessary for a second man to hold the operating handle whilst the contacts are being examined. Irrespective of the form of operation adopted, the mechanism forms a complete unit with the top plate.

As we have said, when duplicate bus-bars are provided the selection of one or other set of bars can be effected by removable plugs or oil-immersed selector switches. In the case of the first method, only one set of removable plugs is provided for each switching unit of the board, and they are inserted in either the upper or lower portion of the hood, whilst in the case of the other method the change-over selector switch is mounted in an oil-filled chamber carried on the top plate of the breaker, and is operated either by hand or by a motor. If desired, the change-over can be effected without interrupting the circuit, although normally an interlock is provided to ensure that the main oil breaker is opened before the selector switch is operated. Two types of blade for this purpose are available, one being a single blade making contact on one side or the other, whilst the second is a fan blade which can make contact with both sides simultaneously. An automatic "tell-tale" indicates the set of bars to which the circuit is connected. For the smaller metal-clad units plug changing is invariably adopted, but for all sizes either method of selection is possible. Nevertheless, for units of heavy current capacity, it is recommended that oil-immersed selectors be adopted, since with plug changing the weight of the plugs and the time taken to change them are considerable.

The locks and interlocks fitted on English Electric metal-clad switchgear may be summarised as follows:—(*a*) Protection of the main isolating plug openings by automatic dust-tight shutters, which are closed by the action of racking the switch out, and each set of shutters may be padlocked in the closed position. (*b*) Protection of potential transformer plug openings by similar automatic dust-tight shutters, which can also be padlocked in the closed position. (*c*) Protection against any attempt to withdraw the moving portion when the circuit breaker is closed, as the first movement of the racking handle trips the oil circuit breaker, and this interlock also acts in the reverse direction to prevent plugging in the moving portion when the circuit breaker is closed. (*d*) Protection against lowering the tank when the circuit breaker is alive. (*e*) Prevention of the moving portion inching out, owing to vibration. (*f*) Prevention of the moving portion jumping when the breaker opens under heavy current, by the provision of holding-down devices at the corner of the top plate of the breaker. (*g*) Prevention of access to the potential transformer fuses until the transformer has been completely withdrawn from the line contacts. (*h*) Selector switches for the duplicate bus-bars are interlocked, so that the current cannot be broken on them, and the main oil breaker can only be closed when the selector switches are fully engaged on one or other set of bus-bars. (*i*) With plug changing for duplicate bus-bars the moving portion of the metal-clad unit cannot be rocked in until all three plugs are in the correct position for connection to one or the other set of bus-bars; and (*j*) locking pins are provided for locking the moving carriage in either of the three positions, *i.e.*, "in service," "test," and "fully out." If any additional system of padlocking is required, it can usually be supplied.

All instrument and relay wiring on the units is carried out in V.I.R. cable of distinctive colours, in accordance with the British standard specification, and is run in rigid or flexible metal tubing, according to the situation of the unit. When pilot cables have to be run to some other point provision is made for multi-core cable-boxes. The small wiring contacts are of the knife type, instead of the usual cylindrical plug and socket type. In order that all small wiring connections may be tested without making the oil breaker alive, a small wiring test-box can be supplied. Cable earthing is effected by means of a portable extension piece fitted to the lower set of main contacts and an earthing connection fitted to the upper contacts. The moving portion is racked to the test position until the extension piece makes contact with the cable connections, and earthing is then effected by closing the oil circuit breaker. In this way the cable is earthed through the main circuit breaker. A simple device can be supplied for raising and lowering the oil circuit breaker tanks, and for use in buildings devoid of a crane a transport carriage can be provided to carry the complete moving portion. When a crane is available, it is usually possible to lift the moving portion and to lower

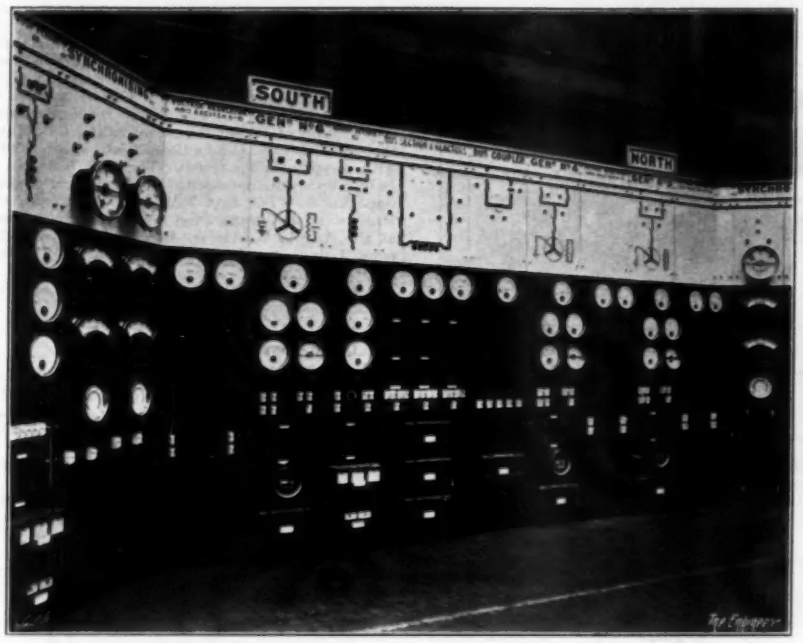


FIG. 5—REMOTE CONTROL BOARD

FIG. 7—SELECTOR CHAMBER

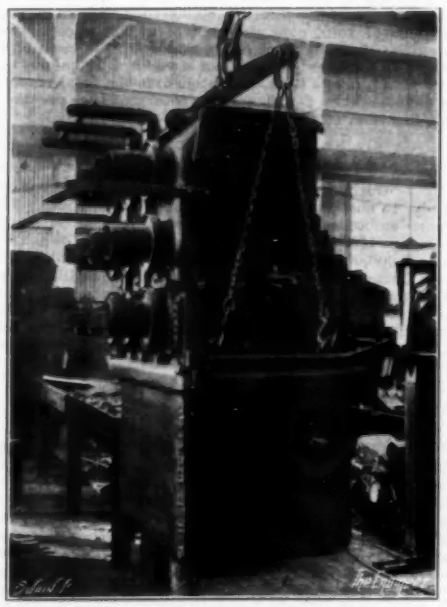


FIG. 6—MOVABLE PART OF SWITCH UNIT

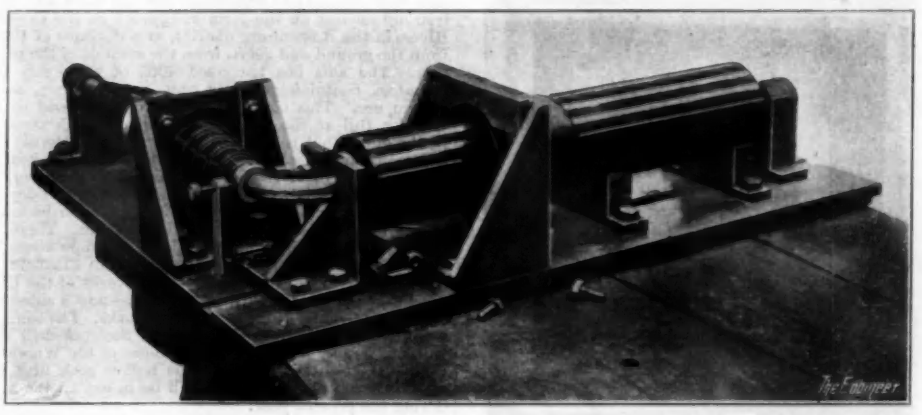


FIG. 8—CIRCUIT BREAKER BUSHING ASSEMBLY FOR 33,000 VOLTS

it on to a flat bogie, and for such conditions suitable lifting frames are supplied for interposing between the crane hook and the apparatus. Indicating instruments are mounted on a panel fixed above the bus-bar chambers, whilst relays and integrating or recording instruments are usually carried on a swinging panel in front of the potential transformer at the base of the unit, and the panel is arranged so that it can be swung back to obtain access to the transformer or, alternatively, separate instrument panels are provided.

Illustrations of a smaller metal-clad unit than that referred to at the outset—*i.e.*, for 500,000 kVA—are given in Figs. 6 and 7, the former showing the complete moving part of such a unit suspended from the crane hook, and Fig. 7 the oil-immersed selector chamber for this unit. The handle and gearing through which the selector blades

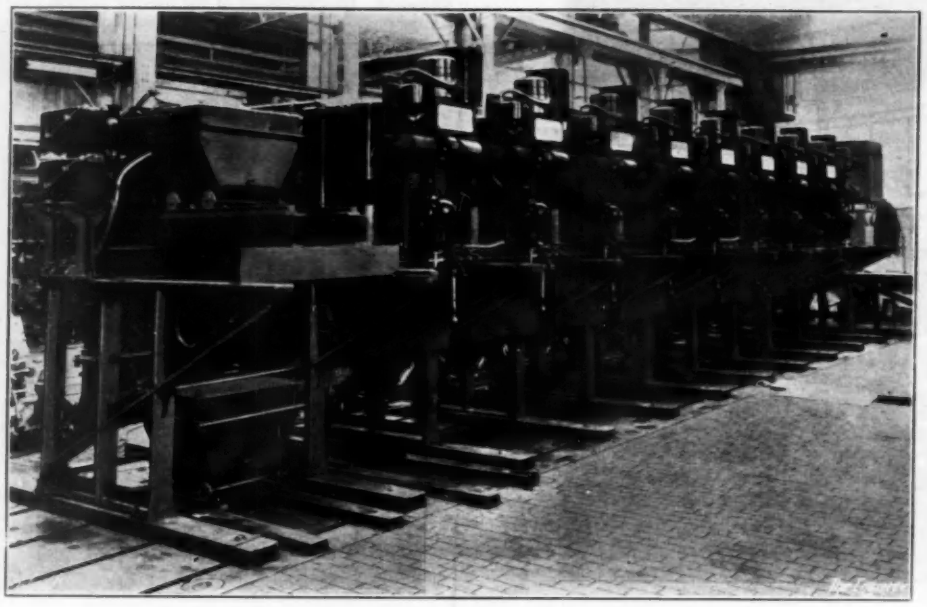


FIG. 9—MOTOR-OPERATED METAL-CLAD SWITCHGEAR FOR NEW ZEALAND

are operated are shown, together with the mechanical indicator for indicating which bus-bar is in service. The operation of assembling the oil circuit breaker bushing and the cable insulator bushing in its jig for a 33,000-volt metal-clad pillar is shown in Fig. 8, the bushings being of the condenser type. The method of accommodating the current transformers in the special chamber provided at the rear of the metal-clad units is shown in Fig. 10. In the works these chambers are tested for oil-tightness by filling them with very thin oil, which soon finds its way through joints that may be faulty, but the oil used for service conditions is, of course, thick oil. An interesting example of a motor-operated metal-clad switch installation is

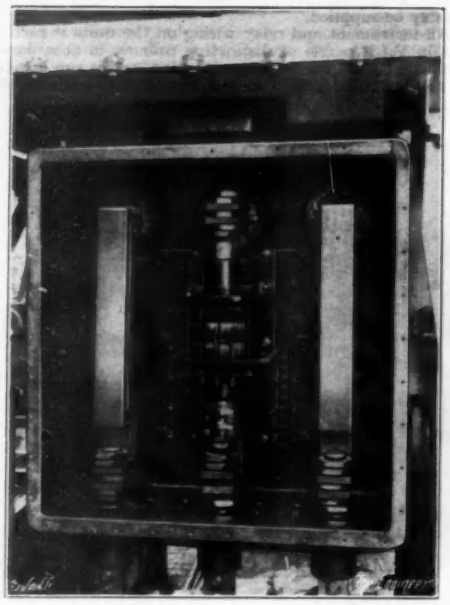


FIG. 10—CURRENT TRANSFORMER CHAMBER

shown in Fig. 9, where each of the units is operated by a small electric motor, mounted on top of the unit. On the left the illustration also shows potential transformers, one connected to the bus-bars and the other to the cable.

It is announced that most of the money granted by the Indian Geological Department to meet the cost of a search for helium is likely to be spent in Burma, where there is a reasonable chance of helium being found in the emissions of gas from the numerous oil wells. At present, however, there is no definite evidence that the Burma oil wells will produce helium on a commercial scale.

South African Engineering Notes.

The Pretoria Steel Works.

Dr. van der Byl, at the second annual meeting of the S.A. Iron and Steel Industrial Corporation, fully reviewed the position, and gave much interesting information. The policy of the Government, he stated, was not to compete with existing industries, but to contribute in a very substantial measure towards building the foundation of the engineering and other industries of the country by the manufacture of iron and steel, and as a fundamental principle to confine the efforts to the production of primary steel products, such as rails, sleepers, building sections, sheet bars, light plate, billets, ordinary merchants' requirements, and reinforcement and wire rods. It is proposed as an initial installation to provide for—(1) a battery of fifty-seven coke ovens capable of producing 450 tons of coke per day, together with a by-product plant; (2) one blast-furnace capable of producing up to 500 tons of pig iron per day; (3) two steel smelting furnaces, each of a capacity of 100 tons, and one mixer of a capacity of 400 tons. The estimated cost of erecting the works at Pretoria is £3,866,835, to which is added £1,026,000 for starting up expenses, engineering administration, &c., working capital and contingencies, bringing the total up to £4,892,885. To that must be added an amount of £596,500, made up of such items as the purchase of properties, investigations, &c., acquisition of the assets of older corporations, &c., making in all £5,489,335. The total funds authorised by law for the establishment of the industry amounts to £5,500,000.

Hematite Development.

It is stated on good authority that the S.A. Iron and Steel Industrial Corporation has put in an adit on its iron ore deposit on the farm Vliegpoort on the Crocodile River, in the Rustenburg district, at a distance of 1000ft. from the ground and 200ft. from the summit of the mountain. The adit has traversed 40ft. of extremely pure hematite, containing 68 per cent. metallic iron, and is still in ore. This confirms the statement made by Dr. van der Bijl at the annual meeting of the Corporation, to the effect that the quantity of ore in the deposit is so enormous that most of the operations for many years to come will be open cast or adit mining. Moreover, the cost of mining this ore, which is among the richest deposits in the world, will be relatively low, and it can be loaded in the bunkers at Pretoria for 10s. per ton. There is a high probability that much of the high grade steels and steel products which come to Africa from Sheffield and Sweden may in future be made at the works of the Union Steel Corporation of South Africa, Ltd.—now a subsidiary of the State-controlled iron and steel works. The company has already decided to manufacture the rock-drill steel, which is largely used in the gold mines of the Witwatersrand. It is anticipated that the hollow rock drill steel manufactured at Vereeniging will be in use on the mines during the present year.

Phosphatic Rock.

There are at Palabora in the Leydsdorp district on the Northern Transvaal, millions of tons of phosphatic rock of very high grade, which, when ground fine, is a valuable fertiliser that can be applied direct to the soil. It contains both phosphate and lime, which the soil moisture renders soluble. What is known as rock meal has been extensively used in Europe with useful results. It is believed that the Northern Transvaal product can be manufactured and marketed at a profit, and that it can, in fact, be sold at a lower price than any other phosphate on the market.

New Gold Mining Scheme.

A provisional agreement has been arrived at between the Union Corporation and the Marievale Nigel Company, Ltd., having for its object the resuming of operations on the Marievale property. The agreement is to be submitted to a special meeting of shareholders, to be held in London at an early date. There is thought to be no doubt that the shareholers will welcome the opportunity to restart operations on the property under the influential auspices of the Union Corporation. The number of claims is over 700, and consists mainly of the mynpacht on the farm Marievale Nigel, split up into three portions, all adjoining Vlakfontein. Prospecting on the property in the 'nineties revealed very rich shoots of reef, the full significance of which was not recognised at the time. To-day the behaviour of the reefs in the district is much more clearly understood, thanks to the work done at the Sub Nigel, and it may be the Marievale Nigel and the adjoining Vlakfontein may form the nucleus of a new gold producer for the district.

Cardiff Coal for the Congo.

Regular shipments of copper over the new line from the Belgian Congo to Lobito Bay have now begun, and 3000 to 4000 tons of ingots and matte are being despatched monthly by the Lobito route, while the Benguella Railway management is contemplating the importation of Welsh coal, contending its ability to load through Lobito at Dilolo, Cardiff coal at prices competitive with those from the south. The time factor in favour of Lobito by comparison with southern ports is also of great importance. The first load of copper from the Union Minière to be despatched over the new route arrived at the Angola border on June 8th, and was despatched from Lobito on June 28th to Antwerp. Regular bi-monthly shipments are now being arranged, bringing Antwerp within forty days of the plants of the Union Minière Katanga.

Union Supplies of Nitrates.

About the end of September the Prime Minister of the Union will be invited to open a new factory for the manufacture of synthetic ammonia and nitric acid. The factory is at present being erected at the Modderfontein factories of the African Explosives, Ltd., under the supervision of the technical experts from the staff of Imperial Chemical Industries, Ltd., who have come to South Africa for that purpose. The importance of the project rests upon the fact that South Africa will for the first time be made independent of outside supplies of nitrates, which are essential in a country both for agricultural and military purposes. The new plant will supply all the nitrogen required now for the manufacture of explosives in South Africa.

Oil from Union Torbanite.

There is no doubt that at last, after a number of abortive attempts, something definite is to be done to give the Union its own oil supply. All efforts to find an oil well in this country seem doomed to failure, and although considerable progress has been made with experiments in the extraction of oil from coal, the question to be solved is the production at a cost that would compete with the imported petrol. The torbanite deposits of the Ermelo district of the Transvaal have been well known for many years, and their richness in crude oil has been commented upon by such authorities as Mr. E. H. Cunningham Craig, the late Mr. G. A. Troye, and Major Trevor. It is these deposits that a company has now been formed to exploit, with a capital of £300,000. The proposed capital expenditure is £175,000 on mining equipment, retort and refinery plant, buildings, working capital, &c., and £120,000 is to be paid to the vendor company for a licence to use certain processes and inventions, &c. A quantity of no less than 10,500,000 tons with an average thickness of 10in. over the area of 21,000 is estimated. Using the Mauss type of retort and upon the basis of an output of 400 tons per day and a yield of 70 gallons per ton treated, it has been estimated that the total revenue per day should be £1210, and the total expenses per day a little less than £600.

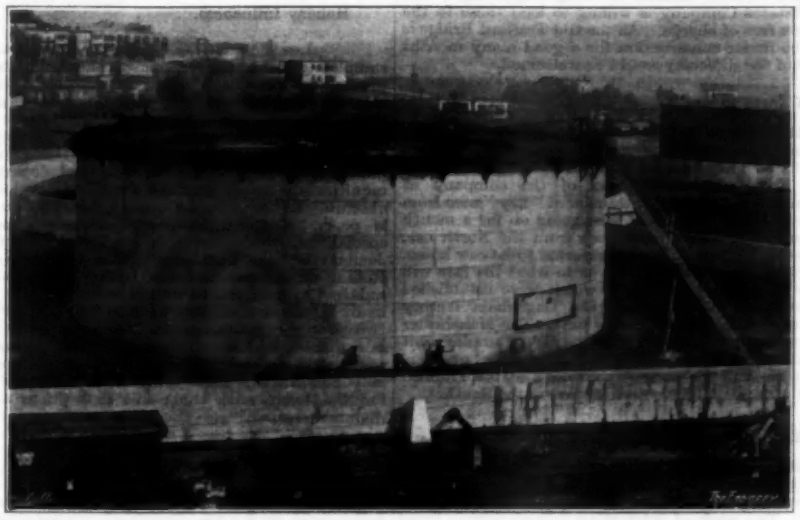
Durban's New Water Scheme.

Durban proposes to obtain an additional water supply, to cost £1,181,103, from the Umgeni River. The scheme embodies the storage reservoir formed by a concrete dam 120ft. high and 1300ft. long, capable of holding up to 5,000,000,000 gallons of water. If adopted by the Town Council, the scheme will be completed in 1939. The water engineer's report discloses the interesting fact that a loop in the river approximately 40 miles upstream distinguishes the scheme. The storage is estimated to yield 50,000,000 gallons a day from a distance away of 40 miles, and the storage site is so placed that it is capable of isolation during flood.

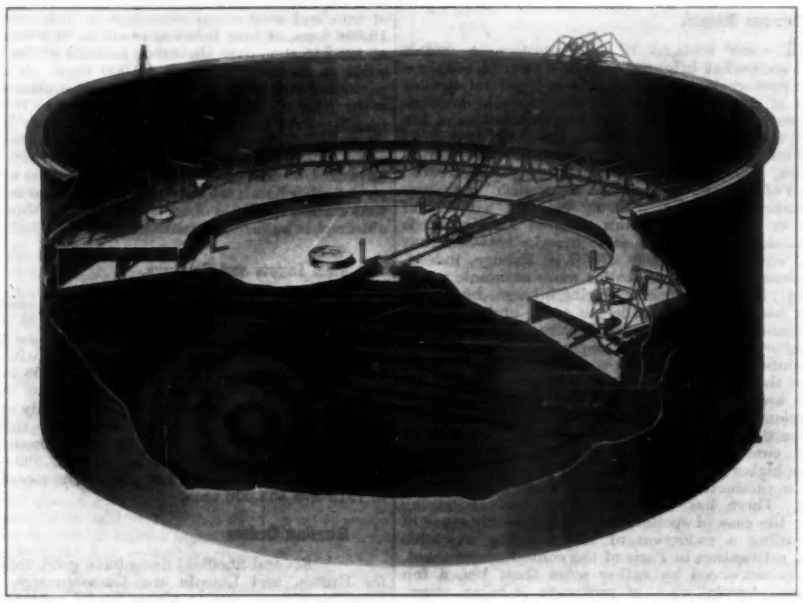
Victoria Falls Electricity.

The report of the technical advisers to the Colonial Office on the proposed installation of a hydro-electric plant at the Victoria Falls, to supply the town of Livingstone, Northern Rhodesia, with light and power, has been published. It mentions the lease now held by the Victoria Falls and Transvaal Power Company and that company's rights to develop power to the extent of 250,000 electric horse-power. After reviewing the conflicting reports of the consulting engineers, Mr. Val Davies and Mr. Stewart, the former opposing and the latter favouring a hydro-electric scheme from the economic view point compared with coal, the report adopts Mr. Davies' estimates of revenue as more probable for some years, thinking Mr. Stewart's optimistic, but it agrees with Mr. Stewart that a hydro-electric scheme is preferable to one based on coal. Summarising the detailed calculations, the report estimates a total capital investment of £80,000 with a steam plant and £114,000 with a hydro-electric plant at the Silent Pool. The total annual expenditure with a steam plant is estimated at £13,750 to cover which, on the basis of 883,600 units, an average rate of 3·75d. is needed. The total annual expenditure with a hydro-electric plant is estimated at £13,710, but that covers additional energy sufficient to supply 240,000 units to the falls area, making a total of 1,123,000 units, so that only an average rate of 2·93d. would be needed. The report adds that comparisons on the same basis of units sold approximate closely to, but the margin favours, the hydro-electric plant. Further, such

THE WIGGINS PONTOON ROOF FOR OIL TANKS



PETROL TANK OF 1¼ MILLION GALLON CAPACITY WITH PONTOON ROOF



PONTOON ROOF IN SECTION

plant would be more enduring. The advisers therefore are decidedly of opinion that the establishment of a hydro-electric scheme would be more advantageous, not only because it would show an immediate advantage, but because, also, of future possibilities. The advisers suggest that the Government should grant the V.F.P. Co., a concession to generate and distribute electricity under the usual obligations as to price in Livingstone and the surrounding area or permit the Livingstone municipality to do it.

Pontoon Roofs for Oil Tanks.

The oil industry, since its beginning, has always suffered from two sources of loss, namely, evaporation and fire. In recent years considerable attention has been given to the prevention of evaporation. To this end reduced quantities of oil are stored in open reservoirs, storage tanks are painted in light colours to reflect the sun's rays and improved tank vents are used. In a few instances the tanks have been insulated. What is claimed to be probably the most effective method of preventing evaporation and fire in storage tanks is their equipment with floating roofs. While experimental work has been done on floating roofs for a great many years, it has only been since 1923 that they have become practical.

The Wiggins floating roof, of which illustrations are given herewith, consisted in its original form of an open pan type deck with a long sliding contact seal to close the space between the deck and the tank shell. The deck has recently been re-designed to embody the pontoon principle, and the structure is now known as the Wiggins pontoon roof. The deck of the roof consists of a ring of pontoons round the outer edge and a single thickness of steel plating over the central portion. The pontoons constitute a continuous annulus and have air-tight bulkheads, which cause each section to act as a separate pontoon. The deck rides directly on the surface of the oil in the tank, blanketing it at all levels. When the tank is emptied completely the deck rests on a light structural framework which remains in the bottom of the tank.

The seal which closes the space between the deck and the tank shell is of the same type as that which has been used successfully on Wiggins' roofs for the past eight years. It consists of a ring of tail shoes held against the tank shell by a system of hangers. The tops of the shoes are joined to the deck by a flexible material. The shoes form a long sliding contact with the tank shell. Although this connection is not air-tight, it is effective in stopping loss, as any opening between the shoe and tank shell is in the form of a tall narrow slot. The opening is too narrow to permit air currents to circulate over the oil surface. Consequently the air immediately over the oil remains still and continued evaporation does not take place. There is a small gas space between the shoe and the tank deck. The ring of pontoons forming the outer portion of the deck is adjacent to this gas space and insulates it and the oil beneath it.

The Wiggins pontoon roof is claimed to have proved very effective in preventing evaporation loss in hot climates. The insulating qualities of the pontoons reduce the tendency of light oils to boil at normal temperatures. The underside of the pontoon roof deck is built so that it slopes upward slightly toward the centre. Should the liquid beneath the roof begin to boil and form gas bubbles below the surface of the liquid, the gas bubbles on rising to the underside of the deck would be trapped beneath the centre of the deck and held there until the temperature fell sufficiently to allow the gas to condense to a liquid again. The seal is equipped with vents to allow for thermal expansion or to release any air which may enter the tank through the filling line. It is also equipped with a drainage system to carry off any rainfall which may collect on the top of the deck. The roof is claimed to reduce fire risks, as it completely blankets the oil in the tank at all times. There is no inflammable gas mixture inside the tank. The oil does not come into contact with the air and consequently it cannot become ignited. The roof is constructed entirely of heavy steel plates with riveted or welded joints. No gaskets are used and the use of light sheets is avoided to ensure the roof having a long life.

The Wiggins roof is manufactured and erected in the United States of America by the Chicago Bridge and Iron-works. The Wheeling Foundry and Engineering Company, Ltd., of Darlington, England, and the Motherwell Bridge and Engineering Company, Ltd., of Motherwell, Scotland, are licensed to manufacture it in Great Britain.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Awaiting Enlightenment.

A CAUTIOUS policy has been adopted this week by Midland industrialists who have been anxiously awaiting enlightenment as to the concrete proposals of the new Government. At the time of writing no one here knew exactly what was in store for them, and only guesses could be made as to what measures would be taken to ensure national stability. It is hoped that we are now at the starting point of a real advance, and industrialists throughout the Midlands are one and all eager to take part in the race for the goal. Confidence is increasing, and enterprise will not be lacking.

Manufactured Iron.

The Staffordshire finished iron trade is making but a poor output, and ironmasters are carrying on under difficulties. They have hopes of a trade stimulus in the autumn, and for this they are eagerly awaiting. The industry is greatly in need of a filip, consumptive demand being very much below the resources of the district. Many of the consuming industries are taking what is relatively only a small quantity of material, and Staffordshire mills are only able to carry on, as it were, from day to day. What the future holds in store for ironmasters cannot be foreseen, but producers of common bars are hoping for some alleviation of the at present unanswerable competition from the Continent. It has been generally stated for the past twelve months that there is little hope for improvement in this branch of the Staffordshire iron trade as long as foreign material can be brought into this district free of all import duties. Ironmasters producing best grade bars are not similarly affected by competition from the Continent, and in their case progress must come by way of increased consumptive demand, and this, it is hoped, will be brought about by increased confidence and revived initiative on the part of consumers. Values of Staffordshire finished iron show no change on the week. Marked bars are £12 at makers' works, Crown quality sells at £9 upwards and nut and bolt iron is quoted £8 7s. 6d. delivered; wrought iron gas tube strip at £10 12s. 6d. is in fair request, but sales are down on a month ago.

Raw Iron.

Blast-furnacemen in the Midlands are just about disposing of their output. Users in this area have for a long time past adopted a policy of hand-to-mouth buying, and there is nothing in the present uncertain position to warrant any change of attitude. Foreign pig iron is at the moment unsaleable in this district, and any change in fiscal policy on the part of the new Government would not affect this branch of Midland industry to the same extent as many others. Nevertheless, Northamptonshire smelters who come into competition with the foreigner when competing for business in the northern markets, are speculating as to the chances of getting a better price for their iron in these markets in the near future. Black Country foundries and forges are no better off for work than they were a week ago, and small tonnages of pig iron are sufficient to satisfy their current needs. Sales of forge iron are quite a small feature of the market. Selling prices remain on the basis fixed by the Central Pig Iron Producers' Association. Derbyshire and North Staffordshire No. 3 foundry irons are £3 6s., and Northamptonshire foundry £3 2s. 6d. Forge grades are 5s. less in each case. All quotations are per ton delivered in the Black Country zone, and subject to a graduated rebate according to the quantity taken.

Steel.

There has been very little business transacted in the steel department this week. Neither finished nor semi-finished material has been called for except in very small parcels. The future of steel prices is rendered uncertain by this week's happenings, and until some pronouncement is made of the new Government's policy business in steel is likely to hang fire. Practically all offers of steel from foreign sources are being turned down for the present. There has been much speculation in Birmingham steel circles as to the probability of import duties being imposed, and also as to the economy measures likely to be adopted. The outlook is obscure at the moment, but is likely to become so much clearer in the near future, that it is not to be wondered at that industrialists generally are delaying decisions and holding back new operations. Steel prices are unaltered. Finished material sells at the prices fixed by the Association, while quotations for half-products vary, sellers being ready to make concessions for substantial orders.

Galvanised Sheets.

Galvanised sheet prices continue to deteriorate under stress of severe competition. Since price control was removed three months ago, values have gradually declined until at date as low as £9 2s. 6d. per ton f.o.b. is accepted for export orders. Mills are generally short of orders, and producers are eager to keep plant active. In all overseas markets British makers have keen competitors, and business can only be secured by sacrifice of profits. That they are meeting with some success as far as securing orders is concerned is shown by the fact that shipments of galvanised sheets were larger last month than recently. Indian demands improved from 3310 tons in June to 5778 tons in July; Scandinavia and the Dutch East Indies were also helpful, but Australia was practically a stagnant market, taking only 17 tons. The home trade in galvanised sheets is maintained, and selling prices are on a higher level than those applying to export business. Galvanised corrugated sheets of 24 guage for home consumption sell at from £9 10s. to £9 12s. 6d. per ton at works.

Successful Trading.

The Brightside Foundry and Engineering Company, Ltd., of Sheffield and Birmingham, is to be congratulated upon a successful year's trading. The year's operations have resulted in a profit of over £5000, to which was added the amount brought forward of nearly £14,000. The company is to pay a dividend of 4 per cent, less tax, on £100,000 £1 ordinary shares, which will absorb £3100, and leave a balance to carry forward of nearly £14,000.

Increased Exports of Birmingham Goods.

It is encouraging to find in the official trading returns that in July there was an expansion in export of many metal manufactures in which Birmingham and the Black Country are especially interested. The improvement, though not very marked, was widely distributed, embracing such commodities as stoves, grates, and sanitary cast iron goods, anchors, chains, &c., bolts and nuts, nails and screws, wire and wire manufactures, bedsteads and hollow-ware. Despite improved shipments of these goods, all the branches of industry to which they belong are at date short of work, some of them having considerable difficulty in remaining active at all.

Orders for Railway Equipment.

Some welcome orders for railway rolling stock for both home and foreign railways have recently reached Birmingham. The Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., of Saltley, is to supply the Southern Railway with 100 4-ton open type steel containers, which, though required particularly for traffic from brick yards, are designed to be suitable also for general purposes. This firm has also received contracts for thirty four-wheeled metre-gauge low-sided open wagons, required for stone traffic on the Gondal Railways, India, and for three-bogie passenger brake vans for the Shire Highlands Railway (Nyasaland), Ltd.

Better Trade Returns.

Midland industrialists were glad to find that the official statistics of imports and exports for July showed improvement on recent months, and particularly so as it was in manufactured goods that substantial increases of exports were recorded. It is noted that while in June, eighteen out of the twenty groups of manufactures showed a decline, in July there was an advance in every one of them. A larger tonnage of iron and steel and manufactures thereof was shipped overseas last month. Unhappily, the returns show considerable instability in the trade in railway material. We imported during July less iron and steel than in June, but while less pig iron came in, an increased volume of steel semis was shipped to us. Imports of hoops and strip, plates and sheets, wire rods, wire, tubes, pipes and fittings also increased.

Strike of Nut and Bolt Workers.

Eight firms and approximately 2500 employees in the Darlaston (Staffordshire) nut and bolt industry were affected last week by a strike which arose over a reduction of the bonus of pieceworkers from 50 to 40 per cent, or a net reduction of 6¾ per cent. of the total earnings. There was to be no reduction in the wages of day workers. The strike was short-lived, the men returning to work on acceptance of the terms laid down by the manufacturers, but on condition that no further reductions of pay shall take place within the next twelve months. The employers verbally agreed to give an undertaking to this effect, on condition that the arrangement is applicable throughout the country and forms part of a national agreement. It is pointed out by the manufacturers that this adjustment in piece rates had previously been accepted in the bolt and nut trade in other districts, and a similar reduction in this district in allied trades.

Increased Employment.

As anticipated, the most recent unemployment returns for the Midlands area show a decrease following upon the August holiday period. There are now 265,465 wholly unemployed, 146,560 temporarily stopped, and 699 normally in casual employment, making a total of 412,724. This is 21,231 less than a week before, though it is 116,284 more than in the corresponding week a year ago. Unfortunately, the Birmingham figures are still advancing, being some 400 up on the week. All the other Black Country towns record decreases. In the Stoke-on-Trent area the figures have fallen from 50,321 to 41,710.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Bridging the Gap.

THE closing of Old Trafford bridge, one of the principal gateways to the Trafford Park industrial district of Manchester and to the Manchester Ship Canal, for the purposes of reconstruction has created keen controversy and protests from industrial interests have showered upon the Salford Corporation, which is responsible for the work of rebuilding, and upon whose orders the bridge was closed to vehicular traffic on August 12th. As alternative routes to and from the Trafford Park and dock areas transport has the choice of Regent Bridge and Barton Bridge, but in a good many instances, both these routes involve loss of time and extra charges. These are the principal grounds of the protests made by the Trafford Park Traders' Association, which includes most of the engineering concerns, and there are many of them established in the district. A favourable development, which was the outcome of a conference this week between a deputation representing the Association and the Mayor of Salford and the Salford City Engineer, Colonel E. B. Martin, is that the Corporation will consider the advisability of building a bridge capable of taking moderate loads, the matter being put down for discussion at the next meeting of the Building and Bridges Committee. It was mentioned in the course of the negotiations that the Trafford Park Estates Company had in stock two bridges which appeared to be suitable for temporary bridge work, and the Estates Company is willing to lend these to the Corporation free of charge. As the Old Trafford Bridge is likely to be under construction for a good many months a way out of the difficulty would be welcomed.

From North to South.

Rather conflicting reports have been current here during the last few days as to the position of the large Ford works at Trafford Park, Manchester, in relation to the new European headquarters of the company at Dagenham, Essex. A gradual transfer of "key" men from Manchester to Dagenham has been going on for a month or two, and some of the machinery from the North has, it is understood, already been transported to its new home. There is considerable uncertainty as to what the fate will be of the Trafford Park works, which were established about twenty years ago, when the Dagenham factory gets into its stride as a producing unit. The Manchester *personnel* is to be offered the opportunity of employment at Dagenham, and it is expected in certain quarters that by the end of the present year most of the Trafford Park staff of 3000 will have been settled in the South.

The South American Markets.

It is hoped that Lancashire industries will be adequately represented on the exhibition ship which leaves this country early in November for a tour of South American countries. The work of interesting manufacturing firms in the venture is being actively carried on, and space has already been taken up by several engineering concerns in this part of the country.

Non-ferrous Metals.

In some sections of the non-ferrous metals markets a somewhat brighter tone has been in evidence during the past week, and there has been a general upward movement of prices. Perhaps the most notable development has been in the tin section. The publication of the outline of the quota scheme which has been agreed to by the four leading producing countries—the Dutch East Indies, Malaya, Bolivia and Nigeria—has created a good deal of interest, and has had a "bullish" influence on the market. The degree of success that will attend the effort to secure a minimum price of £150 a ton is problematical, for there is a wide margin between that figure and current levels, but it will be strange, indeed, if the agreement does not make for more economic prices before long. In the meantime, buying interest during the past week has been on a moderate scale, and a further advance of about £2 10s. a ton has been registered. Copper is a shilling or so dearer on balance compared with a week ago, but confidence in the metal is still lacking, and prices current at the moment of writing are only fractionally above the lowest ever recorded. The dominant factors in this section, as they have been for a long time, are that demand for the metal both in this country and in other important consuming centres, shows little indication of reaching higher levels, and that in spite of the attempts to regulate production stocks show little indication of subsiding. There has been a fair amount of buying interest in the case of spelter, and under the influence of news regarding a reduction of the quantity available and of the ratification in Paris of the combine agreement, values have advanced by rather more than 10s. a ton and a more cheerful view of prospects is being taken. Although the demand for lead has been quiet, values have firmed up substantially, largely, it is held in sympathy with spelter.

Iron and Steel.

There has been a little more inquiry in circulation in the pig iron section, some of it from the bigger users, although there has been no actual increase in the tonnage bought, and makers are not disposed to look for much until next month. Prices keep steady at 67s. per ton, delivered equal to Manchester, for Derbyshire, Staffordshire and Cleveland brands; 65s. 6d. for Northamptonshire; about 87s. 6d. for Scottish, and 81s. for West Coast hematite. Bar iron is maintained at £9 15s. per ton for Lancashire Crown quality, and £8 5s. for seconds, but the demand for it is as quiet as ever. Some inquiry for boiler plates has been the chief feature of the steel market, but, apart from this, business has been slack, notwithstanding reports of better conditions among one or two firms of constructional engineers. Rollers would welcome a resumption of contract buying, but of this there is little indication, and new bookings are almost invariably confined to early rolling specifications. Boiler plates at about £8 17s. 6d. per ton are inclined to weaken, but in most other respects the steel market is firm, with sections at £8 7s. 6d., joists at £8 15s., general plates at £8 17s. 6d., large bars at £9 7s. 6d., and small re-rolled bars at about £6 10s. Quotations for imported iron and steel materials on this market have found still lower levels, but there is little anxiety for users to commit themselves for more than early needs.

BARROW-IN-FURNESS.

Hematite.

There is an entire absence of life in the hematite pig iron market. Stocks have increased at some works and there appears to be an entire lack of confidence among buyers. They are limiting their orders to bare immediate requirements. If there was more confidence, customers would step in and buy at present-day prices, for, as soon as the general demand improves, iron will certainly be quoted at a higher rate. It is a wonder that a few people have not been inclined to speculate a little, for it is almost certain that there will not be any further cuts. Continental business is slack. The iron ore trade is dull and the position has worsened during the past week or so. The steel trade does not show any sign of reviving at present, and the rail and merchant mills at Barrow are still idle. Hoops and small sections are experiencing a fair inquiry.

SHEFFIELD.

(From our own Correspondent.)

Holiday Influences.

LOCAL trade and industry has not recovered completely from the effects of the holidays, but the pre-holiday position should be restored next week, as already the greater portion of the men suspended for the stoppage have resumed work. At the same time, the absence of numerous works officials on holiday is responsible for extreme quietude in buying. There is some slight improvement in the open-hearth steel department, but inquiries are scarce and the immediate outlook remains obscure. In the ordinary everyday lines of steel activity is poor. Sheffield, however, possesses some valuable specialities, which provide a good deal of work, but the demand for them is adversely affected by the world slump. Rolling mills continue quiet, both as regards sheets and rods. The reduced consumption of colliery ropes has badly hit the trade in best wires, though, at the same time, British wire ropes and cables hold a commanding position in a number of foreign countries. The demand for cold-rolled steel and bright drawn bars has fallen off considerably and there is keen competition from the Continent for the trade, with the result that prices are scarcely remunerative.

The Scrap Market.

The scrap market is still in a state of reaction and record low prices are being offered for basic quality. Sellers hold out for 36s., but this is several shillings above the figure which consumers are prepared to give. Deliveries have increased a little since the resumption after the holiday stoppage, but there is no improvement in buying, and the export business is steadily decreasing. Exports of iron and steel scrap were high in July, amounting to 19,000 tons, or four times as much as in June. The total of 105,115 tons over the seven months of the year represents an increase of about 10,000 tons. A considerable portion of recent exports was under old contracts. Imports of scrap have fallen this year by two-thirds. It is of interest to note that German scrap merchants are urging their Government to restrict importations of iron and steel scrap, and suggest that no foreign money should be advanced by the banks for such trade. The steel-makers, on the other hand, are opposing the proposal on the ground that certain qualities of scrap required by them cannot be obtained in sufficient quantities at home.

Steel Ingots and Castings.

The output of steel ingots and castings in the United Kingdom in July amounted to 428,700 tons, or 200 tons less than in June, but 192,700 tons less than in July last year. The July figure compares with a monthly average of 638,600 tons in 1913, and of 608,200 tons last year. The highest monthly average since the war was 803,000 tons in 1929, and the lowest monthly total 337,200 tons in December. The best figure for this year was 500,000 tons in March. Last month the production of pig iron was 317,000 tons, comparing with 323,800 tons in June and 486,100 tons in July last year. The monthly average in 1913 was 855,000 tons.

Russian Orders.

Several Sheffield firms have good orders on hand for Russia, and Lincoln and Gainsborough engineering firms have been able to secure useful contracts from the same source. Robey and Co., Ltd., of Lincoln, have just received a substantial order for electric winding engines for the coal-mining areas in Russia, following the recent visit to Lincoln of the Chief Technical Organiser of all coal mines in Russia.

Coal-washing Plant.

New plant and machinery costing about £100,000 is being installed by the Ashington Coal Company, Ltd., at Ashington Colliery. The plant, which will be the largest and most modern of its type in the country, will be capable of dealing with 350 tons of coal an hour. The whole of the work in connection with the coal-washing and screening plant is being done by Goodall, Clayton and Co., Ltd., of Leeds.

£96,500 Gasworks Scheme.

The Lincoln City Council is proposing to proceed with a gasworks development scheme which will involve an expenditure of £96,500. The project involves the reconstruction on the most up-to-date lines of the entire works at Bracebridge and the consequent adaptation of the old works at Newland. The scheme will take about eighteen months to complete. It is intended to install a 3,000,000 cubic feet per day plant, which is estimated to be sufficient to meet the requirements of the undertaking for the next twenty years. The authority has been influenced in its decision to accelerate the scheme by the fact that £22,000 of the total cost can be expended on local labour, including skilled labour in the local engineering works.

Huddersfield Road Scheme.

The Huddersfield Borough Council has decided to hold over until October consideration of a scheme for the cutting of a new road which would offer an alternative route to traffic passing through the borough from various West Riding towns to Lancashire. The project has met with considerable opposition on the ground of cost, it being argued that the town cannot afford a "luxury scheme" at a time when it is saddled with a municipal debt of £5,632,160. A further point in the opposition is that the volume of traffic does not justify so expensive a road.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

IT would be idle to pretend that there has been any improvement in the general trade position in the North of England. Conditions in almost every section of industry have been bad for a long time now, and it is difficult at the moment to point to any real hopeful indication as regards the near future, except that it is hard to think that things can become any worse, and that therefore any change that takes place must be for the better Until the political situation becomes clarified, business in all sections of industry is likely to remain in abeyance.

Cleveland Iron Trade.

The Cleveland pig iron market shows little change on the week. Further curtailment of production had reduced output to little more than is expected to be absorbed by current needs, but supply is plentiful. Producers hold to their fixed minimum prices for home business, but unsuccessfully offer iron to Scotland at specially low rates. Pig iron consumers in this district still have a lot of Midland iron to take up against running contracts, but are no longer buying from that quarter. For home purposes No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

A few export orders are still being secured for East Coast hematite pig iron, but home business is dull and restricted to small parcels for early delivery. Producers have no fixed prices, and they are irregular, with a tendency downwards. It is difficult to ascertain the lowest terms on which contracts might be made, but producers are unwilling to acknowledge that values are below the basis of ordinary qualities at 61s. Customers, however, claim to have purchased at less.

Iron-making Materials.

Business in foreign ore is still confined to transactions in spot lots. Nominally best Rubio is 14s. 6d. c.i.f. Tees. Blast-furnace coke continues plentiful, and consumers are buying sparingly. Quotations are based on good average qualities at 15s. delivered at the works.

Manufactured Iron and Steel.

There is still acute scarcity of orders for most descriptions of manufactured iron and steel. An outstanding exception is the constructional steel department, in which producers have good order books and report inquiries on quite a good scale. There is a little more overseas inquiry, but actual business matures slowly.

The Coal Trade.

Market conditions continue quiet, but there are prospects of increased trade. In the course of the next few days there will doubtless be news of some gas coal allocations from abroad. One or two fairly large contracts are pending, as well as several of the smaller kind, amounting to not more than a couple of cargoes. Seasonal inquiries are now coming on and more activity may be expected, although at limitation values business is hard to procure. Declining daylight and cooler evenings are beginning to affect the consumption of domestic fuel, which from now to the winter will steadily increase. Northumberland collieries are picking up more trade on this account, producers of the best grades being at the quota level or beyond it. In one instance a seam which has been closed is to be reopened in the next few days. Northumberland steam coal is going off readily. Merchants anticipate a much improved demand, and consequently quote steady at recent prices. Best qualities are at 13s. 6d. and seconds 12s. Steam small coal is difficult to clear in any volume, but there is a moderate demand to absorb the current output. Stocks on the ground, however, continue to show slight expansion. Best smalls realise 9s., and ordinary 8s. In the Durham gas coal trade, collieries have some difficulty in maintaining present output. There is an abundance of all descriptions at the fixed minimum. Best kinds are offered at 14s. 6d., and seconds at 13s. 3d. to 13s. 6d. Coking fuels are plentiful, and if there is any scarcity of bunkers, it is owing to pits being idle on account of the general slow demand, except for the higher qualities. Best bunkers command 13s. 6d. to 13s. 9d., with seconds plentiful at 13s. There is little business passing in the coke trade, but holders of patent oven cokes are quoting steadily at 15s. 6d. to 16s., buyers finding it difficult to secure a slight discount. Superior foundry coke is unchanged at 17s. to 20s. Gas coke is quite, but steady for best makes at 18s.

SCOTLAND.

(From our own Correspondent.)

Steel.

THE general situation in the Scottish steel trade is unaltered, the passing of yet another week having failed to bring out any indication of a change for the better. Inquiries for all classes of material are few and far between, and the works as a rule are poorly employed. The present position in the shipbuilding industry, with a resultant falling away in specifications, has had a most detrimental effect on the steel industry, especially in the heavy section. Demands for shipbuilding material have been steadily declining for some time past, and there is no sign of improvement. New shipbuilding orders are very scarce, and those which have been placed are as a rule being built for some particular purpose. Tube makers are no better off; in fact, conditions appear to grow steadily worse, with the export trade of a dwindling character. Steel sheets, however, are a fairly bright spot at present, owing to the receipt of some comparatively good orders from the East. Galvanised corrugated sheets, 24 gauge, have been reduced to £10 12s. 6d. per ton for the home trade, with export about £9 15s. per ton, f.o.b. Glasgow.

Iron and Steel.

The position in the bar iron trade is very unsatisfactory. Business is extremely scarce, and makers find difficulty in keeping the works going even three days per week. Home prices are unchanged, but export is down to £9 10s. per ton, and it is said that a lower figure could be touched. Re-rolled steel bars are little, if any, better off. The price remains about £6 per ton home and export, but anything offered for export is open to keen competition.

Pig Iron.

There are only one or two furnaces in blast in Scotland, but outputs are not taxed, owing in a measure to continued arrivals in this district of iron from India and the Continent. It is also worthy of note that imports of iron ore are diminishing. During the past week over 1100 tons of pig iron were discharged at Glasgow, 600 tons of which came from Calcutta. Exports only amounted to 13 tons, compared with 337 tons in the same week last year.

Scrap.

The market for scrap is dull and weak, with cast iron machinery scrap easier at 47s. 6d. and heavy steel unchanged at 37s. 6d. per ton.

Coal.

The home market for Scottish coal is a shade better, by virtue of better demand on home account and the circulation of inquiries on behalf of gas and electricity works. The general industrial demand, however, is still far below normal. The export department is unchanged. Some business has been done with Finland, but other markets have been most disappointing, because, in a large measure, of Polish competition. Transactions as a rule are confined to small lots for prompt shipment, forward business being practically impossible with colliery prices far beyond the basis foreign importers are inclined to consider. All descriptions of round fuel are easily obtainable, and the only sort to show any sign of strength is double nuts. Aggregate shipments amounted to 194,253 tons, against 187,763 tons in the preceding week and 230,626 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal and Allied Trades.

IT is a long time since there was such a dearth of items of interest concerning the industrial conditions in this district. It can be said that the ship-repairing industry is, for the time being, better than it has been for several weeks past, but that is the extent of any improvement that can be noted. Iron and steel operations are as quiet as ever, but there is naturally some speculation whether with the change in the political situation brighter conditions can be looked for in the future. There are those closely associated with the coal export trade who wonder whether this industry may not possibly benefit, especially if there is some relaxation in the regulations governing production and prices. As things are, the conditions in the coal trade are certainly dull and featureless, and the latest figures regarding shipments are by no means good. The view was expressed last week that the returns would not be satisfactory, but it was scarcely thought that the total of shipments for last week would prove as disappointing as turned out to be the case. It is true that bad weather was accountable for tonnage not putting in an appearance as promptly as would have been the case if normal weather had prevailed, but it must also be admitted that the demand for immediate supplies of coal appeared also to dry up. According to the figures of the Great Western Railway Company for the six ports in this area under its control, the total of coal and coke shipments was only 386,820 tons. This was less than the preceding week by 79,280 tons. while, compared with the corresponding period of 1930, there was a reduction of no less than 135,910 tons. This means that up to the end of last week shipments this year are below those for the same period of 1930 to the extent of 4,439,052 tons, the actual figures being 13,917,280 tons, compared with 18,356,332 tons. At the end of last week the number of idle tipping appliances at the docks was forty-two, but, as the result of arrivals of tonnage over the week-end, this number was reduced on Monday to thirteen, with twelve steamers waiting to berth, though, on Tuesday, the number of idle appliances increased to twenty, and there were eight vessels waiting. Still, the position could not be regarded as good, as the inquiry all round for coals was extremely inanimate. In no direction has there been any increased activity. On the contrary, the lack of prompt orders has resulted in a weaker tone on the outward freight market. No fresh news has come to hand regarding the operation of the import licensing sytem in force in France, except that licences for September are not coming along at all freely, so that it is impossible to say what exactly are the prospects for next month.

Coalfield Items.

Recently wage disputes have been in evidence in the anthracite area of the coalfield. At one time it looked as if they would result in idleness on the part of about 800 workmen at the Cross Hands Colliery, belonging to the Amalgamated Anthracite Collieries, Ltd.; but, fortunately, the questions in dispute have been adjusted and the notices which had been tendered by the men did not take effect and work is proceeding. There has, however, been some trouble at the Gwaun-Cae-Gurwen collieries belonging to the same company, and it was the intention of 2000 workmen to tender their notices on Monday last. In the Monmouthshire area, the Tredegar Iron and Coal Company has been compelled to dispense with the afternoon shift at the Tytrist Colliery, and about 200 men who have been working on day-to-day contracts for the past month are affected. Owing to trade depression, quite a number of collieries in the steam coal area have been working very irregularly. The Deep Navigation pits, Treharris, were idle on Monday for the tenth day in succession, while the Taff Merthyr Colliery, Trelewis, was also idle that day owing to lack of orders. After being at a standstill for five weeks because of the installation of a new steel pithead frame, the men, numbering about 500, at the No. 1 pit, Wyndham Colliery, Ogmore Vale, have been able to resume work.

Current Business.

The general tone of the steam coal market has been dull in the extreme, there being scarcely any new inquiry. Lack of orders is not confined to any particular direction, but all markets display quietness. Collieries are operating intermittently as a consequence. Prices all round show no alteration, but remain at the minima. Dry sized coals are relatively the steadiest section. Usually house coal prices are advanced as from September 1st, but it is understood that there will be no increase in best qualities, though it is probable that as from October 1st prices will go up by 1s. 6d. per ton. Patent fuel and coke show no movement, but the feature is the sharp improvement in prices for French pitwood. For some time past comparatively small supplies have been brought forward. At the end of last week and early this week supplies have been scarcely obtainable for spot delivery, and quotations have advanced to 25s. 6d. and 26s.

B.E.S.A. SPECIFICATIONS.

All B.E.S.A. Specifications can be obtained from the Publications Department of the Association at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

ELECTRICAL PERFORMANCE OF HIGH-VOLTAGE BUSHING INSULATORS.

The British Engineering Standards Association has recently issued British Standard Specification No. 223–1931, dealing with bushing type insulators for indoor and outdoor use, including cable terminating bushings, suitable for the range of declared voltages from 600 volts to 200 kV. In general arrangement the specification is similar to B.S. Specification No. 137–1930, dealing with insulators for overhead lines, but an important difference will immediately be noticed, namely, that the "rating number" assigned to each bushing is equal to the voltage, expressed in kilovolts, used in the one-minute dry test, whereas in B.S.S. 137 the rating numbers are based on the voltage used in the thirty seconds rain test. For this and other reasons it is clearly stated in the specification that it must not be assumed that for a given transmission system the same, or nearly the same, rating number will represent both the appropriate bushing and line insulator. Each rating number is associated with certain test voltages—one minute dry test for indoor and outdoor bushings, thirty seconds wet test for outdoor bushings, and minimum dry flash-over voltage for indoor and outdoor bushings—and information regarding the selection and application of bushings is given by means of notes and "bushing selection tables." The notes deal with such matters as the relative strength of bushings and associated apparatus, the effect of details and conditions of installation, and the corrections to be applied for conditions other than the standard service conditions. The bushing selection tables furnish an index of the appropriate bushing rating numbers for various switchgear and transformer applications. Impulse voltage tests are dealt with in one of several appendices.

LANTERN SLIDES.—Marshall, Sons and Co., Ltd., Britannia Ironworks, Gainsborough, inform us that they have an extensive range of lantern slides of steam and oil power plant, road-making machinery, &c., which they will be pleased to loan for lecture purposes.

ANTI-GAS SERVICES, R.E.—It is proposed to hold a reunion and dinner during the forthcoming winter months for all who served with the Anti-Gas Services R.E., including attached *personnel* and Special Brigade R.E. All old members are asked to write for particulars to Mr. H. W. Lucas, 42, Althorp-road, Wandsworth Common, S.W. 17.

AN ARC-WELDING PRIZE COMPETITION.—The Lincoln Electric Company of Canada, Ltd., has sent us particulars of the second Lincoln Arc-welding Prize Competition, the object of which is to increase the knowledge of the adaptability of arc welding to industry. Any person or group of two or more persons in any country of the world may submit a paper to the company, but only one paper from any contributor or group will be eligible. Members of the staff of the Lincoln Electric Company are not allowed to take part in the competition. Each competitor must have participated in the work that forms the subject matter of his paper, and the work described should be the product of a firm or company with which he is or has been connected. The subject matter of the paper must come under one of the following headings:—(*a*) A description of a useful machine, structure, or building that has been completely or partly redesigned, so that arc welding is applied in its manufacture; or (*b*) a description of a machine, structure, or building not previously made, but which has been designed partly or wholly with a view to arc welding, and a description must be given showing how a useful result is obtained, which was impracticable by other methods of manufacture. It is not necessary that the machine should have been manufactured at the time of writing the paper. Comparisons as to efficiency and cost should be made with processes previously used, and the machine described must have actually been designed. Prizes ranging from £1500 to £20 are being offered to winners of the competition, full particulars of which can be obtained from the Lincoln Electric Company of Canada, Ltd., Bush House, Aldwych, W.C. All papers must reach the company's headquarters in Cleveland not later than October 31st.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/- to 20/6
(1) Spanish	14/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 10 0	—
No. 1 Foundry	3 13 6	—
No. 3 Foundry	3 11 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 1 0	3 1 0
No. 1	3 1 6	3 1 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(e) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
,, ,, Foundry	3 6 0	—
(e) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(e) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast— N. Lancs and Cum.— Hematite Mixed Nos.	3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c)	— / — / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 10 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6 to 9 0 0	—
Gas Tube Strip	10 12 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
,, ,, (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.)	10 12 6	9 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
,, (Small Round)	6 10 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	8 17 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	6 7 6 to 7 0 0	—
Billets and Sheet Bars	5 0 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	9 2 6 to 9 12 6	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	13/- to 13/3
Block Tin (cash)	116 17 6
,, (three months)	119 10 0
Copper (cash)	32 10 0
,, (three months)	33 6 3
Spanish Lead (cash)	11 18 9
,, ,, (three months)	11 17 6
Spelter (cash)	11 11 3
,, (three months)	12 2 6
Manchester—	
Copper, Best Selected Ingots	35 15 0
,, Electrolytic	36 15 0
,, Strong Sheets	66 0 0
,, Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
,, Condenser, lb.	0 0 11½
Lead, English	13 12 6
,, Foreign	12 5 0
Spelter	12 7 6
Aluminium (per ton—raw ingot)	£85

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/-
,, ,, 6 p.c. to 8 p.c.	£20 12 6	7/-
,, ,, 8 p.c. to 10 p.c.	£19 17 6	7/-
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£30 0 0	10/-
,, ,, ,, 1 p.c. carbon	£34 0 0	12/-
,, ,, ,, 0·70 p.c. carbon	£35 10 0	14/-
,, ,, ,, carbon free	9½d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
,, ,, ,,	£11 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£15 0 0 scale 7/- per unit	
,, Vanadium	12/9 per lb.	
,, Molybdenum	4/2 per lb.	
,, Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	8/9 per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/6
,, ,, Ell	14/3
,, ,, Splint	14/- to 15/9
,, ,, Trebles	12/- to 12/6
,, ,, Doubles	11/- to 11/6
,, ,, Singles	10/- to 10/3
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	17/-
,, ,, Trebles	12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/-
Screened Navigation	16/6 to 17/6
Trebles	12/- to 13/6
Doubles	11/9 to 12/-
Singles	10/6
Lothians—	
(f.o.b. Leith)—Best Steam	10/9 to 11/-
Secondary Steam	10/6
Trebles	11/6 to 12/-
Doubles	11/9
Singles	10/-

ENGLAND.

	Export.
(8) N.W. Coast—	
Steams	20/-
Household	30/- to 51/-
Coke	20/- to 20/6
Northumberland—	
Best Steams	13/6
Second Steams	12/-
Steam Smalls	7/6 to 8/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-

Sheffield—	Inland.	Export.
Best Hand-picked Branch	24/6 to 25/6	—
Derbyshire Best Bright House	19/- to 20/-	—
Best House Coal	18/6 to 20/-	—
Screened House Coal	17/- to 18/-	—
,, ,, Nuts	14/6 to 15/-	—
Yorkshire Hards	15/- to 16/6	—
Derbyshire Hards	15/- to 16/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/6	—
Smalls	4/- to 5/6	—
Blast-furnace Coke (Inland)	12/3 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 13/- to 14/-		

(9) SOUTH WALES.

	Export.
Cardiff—	
Steam Coals :	
Best Smokeless Large	20/-
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/3
Ordinary Dry Large	17/9 to 18/-
Best Black Vein Large	18/3 to 18/9
Western Valley Large	18/- to 18/6
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/9 to 18/-
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	18/- to 21/-
No. 3 Rhondda Large	19/9 to 20/-
,, ,, Smalls	15/- to 16/-
No. 2 ,, Large	17/- to 17/3
,, ,, Through	15/6 to 16/-
,, ,, Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	19/9 to 20/-
Pitwood (ex ship)	26/- to 27/-
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/- to 37/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	40/- to 46/-
Beans	24/9 to 28/3
Peas	21/- to 22/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/-
Steam Coals :	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate : Joists (minimum), 22/6 Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Industrial Collaboration.

AT a time when orders are scarce and little is being done to ensure a continuance of the programme of national equipment, which was suspended when the supplies of material on account of reparations from Germany were stopped, the danger of that country putting considerable quantities of machinery and other manufactures on the market is regarded as assuming serious proportions. The value of those stocks is estimated at an enormous figure, and so long as they were financed by the banks there was little risk of actual dumping, but French manufacturers believe that the withdrawal of financial support to industry in Germany will inevitably compel makers to dispose of the stocks at almost any price they can get. There is another disturbing factor, based upon the assumption that as Germany depends on an export trade, and is finding markets closed by higher tariffs, she will be obliged to arrange with agricultural countries for an exchange of manufactured goods for produce, as she proposes to do with Austria, and may accomplish with Russia. The French wish to prevent that development at all costs. An example of the way in which business is being done is afforded by an order which has been placed by Yugo-Slavia in Germany for a grain elevator to be paid for partly in wheat. There is an obvious risk in allowing Germany to arrange for the sale of her manufactures under conditions that will ensure for her a virtual monopoly of certain markets, and some French economists therefore suggest a method of industrial collaboration, whereby Germany will be provided with an outlet for machinery and plant required for home and colonial equipment. So long as public works were carried out with German reparations, they provided activity both to German and French manufacturers, but now that the works are suspended, there is very little work for anybody. Therefore, it is assumed that if the German participation can be continued, under conditions that will be satisfactory to Germany, there will be more work in both countries. This, however, implies a financial arrangement whereby France will pay, it may be indirectly, for the German material, but if that be the case French manufacturers will make a stand against it, as they will argue that if the country can finance the whole scheme of public works, they themselves can supply all the machinery and material required.

The Steel Trade.

The operations of the syndicates of producers of semi-manufactured steel, joists and merchant bars have had the effect of maintaining prices on a higher scale, but they have not stimulated business in any way, consumers being for the most part less disposed than they were before to give out orders. The situation is, moreover, seriously affected by the uncertain outlook for the Cartel, which is being renewed from month to month without any fair prospect of its being definitely reconstituted at an early date. Of late, opposition to it has been growing in Germany, where producers now appear anxious to have a free hand to export all the steel they can. This attitude can only be attributed to the present economic conditions in that country, and when German producers have emerged from their troubles, it is possible that they will once more help to place the Cartel—which is their own invention—on a sound basis; but for the moment it is admitted that with the repeated delays the Cartel has lost all influence, and runs a serious risk of dissolution. French steelmakers are now the only strong supporters of the Cartel, and they are doing their best to keep it alive, in the hope that German producers will soon be in a position to help carry through the negotiations.

Tonkin Anthracite.

The anthracite mining companies in Tonkin possess considerable fuel resources, for which there is so little home demand that practically the whole of the production has to be sent abroad, principally to China, Japan, and to ports in the Far East. As production increased, consignments were made to the United States and Canada, and there is now an organisation in France for the distribution of this colonial anthracite. That these efforts are meeting with some success is shown by exhibits of the French mining companies in Tonkin at the Colonial Exhibition. The reason why the companies in Tonkin are able to distribute anthracite to this side of the world is that the fuel usually outcrops, and is quarried at such low cost that it can stand higher freights than anthracite produced nearer to consuming markets. At present, the quantity of Tonkin anthracite sent to this country is comparatively small, but as a colonial fuel of good quality it is well received, and there appears to be no doubt that consignments will steadily increase. How long this expansion of business can continue will depend upon the freights, for if they should rise at any time to a point at which the advantage of low cost of extraction is wiped out, there can be no competition with Welsh anthracite, which, for the time being, is threatened by a French colonial fuel that owes its success in this country to special economic conditions.

Foreign Trade.

The returns of foreign trade show a further decline in exchanges, and there are reductions all round, except in the case of imports of produce. The total value of imports during the first seven months of the year was 26,837 million francs, a contraction of 4102 million francs, as compared with the corresponding period of 1930, and of exports 18,654 million francs, a fall of 7527 million francs. The quantities of imports amounted to 35,291,770 tons, a decline of 28,941 tons, and of exports, 17,948,417 tons, a reduction of 3,662,517 tons. The contraction was more marked in values than in quantities. The exports declined by 29 per cent. in value and 18 per cent. in weight. The imports of manufactured goods were valued at 5634 million francs, a decline of 1153 million francs, and the exports 11,657 million francs, representing a contraction of 4666 million francs. The imports of coal, amounting to 18,320,946 tons, were more than a million tons below the total for the corresponding period of last year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

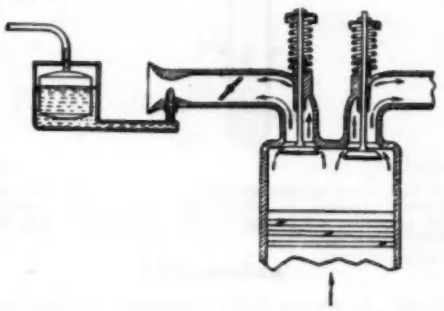
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

353,350. November 7th, 1930.—HEAVY OIL ENGINES, Fuston-Moteurs, Rue Galliéni, Rueil Malmaison (Seine-et-Oise), France.

The idea of this invention is to employ the exhaust gases directly for the heating of the induction pipe, so that heavy oils may be used directly with a simple carburetter. To this end

Nº353,350



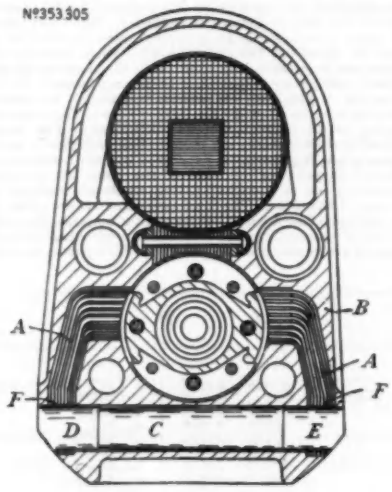
the normal functioning of the inlet valve of a four-stroke engine is so varied that during a short period of the exhaust stroke the inlet valve also is opened. As a consequence, hot gases blow back down the induction pipe, and heat it up for the gasification of the fuel oil. Means are suggested, but not elaborated upon, to prevent the waste of fuel during the period of the blow-back.—*July 23rd*, 1931.

DYNAMOS AND MOTORS.

353,305. September 4th, 1930.—MOUNTING MAGNETS IN IGNITION MAGNETOS, Fabrica Italiana Magneti Marelli, 22, corso Venezia, Milan, Italy.

The invention relates to ignition magnetos and more particularly to the constitution of the field system in which permanent magnets in the form of rectilinear bars are employed. The laminated pole shoes A A of the field system are cast in

Nº353,305

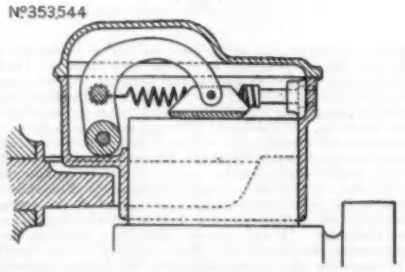


the body B of the magneto frame. Each magnet C of the field system which is composed of a small bar of cylindrical or prismatic shape, has at its ends heads D, E, which taper along the longitudinal axis of the magnet and are engaged in holes F provided in the pole shoes and in the registering portion of the body B. The heads D, E are bevelled and engage the surface of the conical bore F, provided in the body and in the pole shoes.—*July 23rd*, 1931.

353,544. May 1st, 1930.—DYNAMO ELECTRIC MACHINES, E. R. and F. Turner, Ltd., and Francis Hannam Johnson, both of Bull Motor Works, Quadling-street, Ipswich.

This invention relates to brush gear which is totally enclosed to protect the brushes, pressure arms and other moving parts

Nº353,544



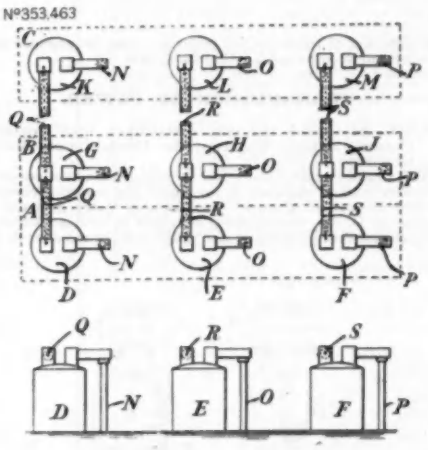
of the gear from clogging, and is particularly applicable to ventilated machines used in exposed situations, where they are subject to ingress of dust and grit. The invention aims at keeping the circumferential width of the gear casing small. The gear of each brush or line of brushes, separately enclosed in a box which is integral with and an extension of the usual holder or box in which the brush slides, comprises a pressure arm rocking in the radial plane of the brush, and pivoted beyond one end of the brush. The arm is preferably pressed on the brush by two independent tension springs, either of which is sufficient to keep the brush up to its work if the other should break. Suitable means are provided for adjusting the spring pressure. The brush box or holder which projects from the casing, as shown, is lodged in a forked brush bar upon which the brush gear casing is secured by screws.—*July 30th*, 1931.

SWITCHGEAR.

353,463. February 24th, 1930.—METAL-CLAD SWITCHGEAR, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and John Christie, of 4, Sidecliff-road, Sunderland.

In the case of metal-clad switchgear for use on extra high-voltage systems, it is desirable that the bus-bars and their connections to the metal-clad switchgear should be oil-immersed and that the bus-bars or conductors should be supported in their oil-containing tubes by condenser-insulators, which are usually of the metal-foil paper-condenser type. The grouping of a number of three-phase circuit-breaker units has hitherto necessitated the employment of comparatively long lengths of condenser-insulators between consecutive circuit breakers in the same phase. It is extremely difficult to manufacture condenser-insulators in one length of, say, more than 8ft. or 10ft., and it is undesirable to make joints in the insulators themselves, or to have joint boxes connecting two or more single lengths. According to the invention the circuit-breaker units are so disposed and arranged relatively to each other and to the bus-bars that these long lengths are avoided and the bus-bar connections to the circuit breakers of each phase are made by short conductors surrounded by single-length condenser-insulators. In the arrangement illus-

Nº353,463

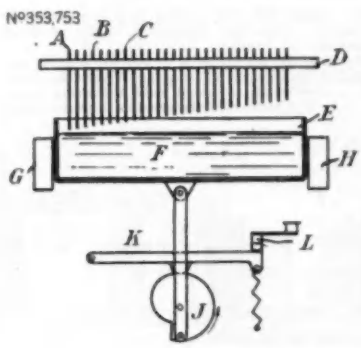


trated one three-phase circuit-breaker unit is provided for each cable or feeder, three such units A, B, C—enclosed in dotted lines—being shown. Each unit includes three oil-immersed single-phase circuit breakers D, E, F—or G, H, J, or K, L, M—one for each phase, and these circuit-breakers are arranged in three parallel rows, with all the circuit breakers in one phase in line with one another. The cable or feeder connections to the circuit breakers are indicated at N, O, P. The other terminal of each circuit breaker is connected to the corresponding terminal of the next circuit breaker in the same phase by means of a short conductor Q or R or S, supported by a single-length condenser-insulator in an oil-filled tube. The conductors Q in the first phase together constitute the bus-bar for that phase, and the bus-bars for the other phases are similarly constituted by the conductors R and S. The arrangement may readily be extended to suit a duplicate bus-bar installation by providing each circuit breaker with change-over switch mechanism, whereby the bus-bar terminal of the circuit breaker can be connected at will to one or other of the two bus-bars, each bus-bar being constituted by a series of short conductors supported by single-length condenser-insulators in tubes containing oil.—*July 24th*, 1931.

353,753. September 11th, 1930.—ELECTRIC SWITCHES, Max Martin Bock, of 61, Alfredstrasse, Hamburg, Germany.

The switch described in this specification is designed to switch in a large number of circuits progressively and to cut them out simultaneously. A, B and C are contact pins connected with the individual circuits, and held in insulating material. D, E is a common contact member in the form of a trough

Nº353,753



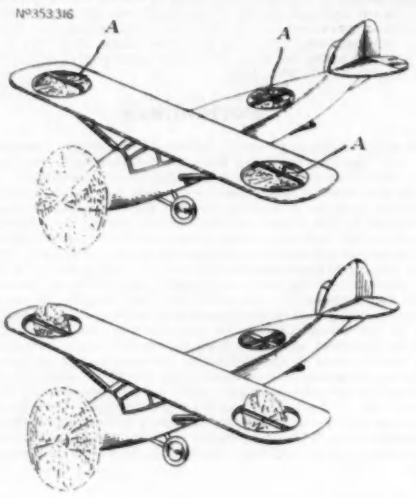
containing mercury F. The trough is adapted to slide between the guides G and H. By means of a motor and a transmission gear the cam J is made to rotate slowly and thus gives a reciprocating motion to the trough E. At the same time that the cam is causing the downward movement of E, the lever K suddenly interrupts the current flowing between two contacts L, which are situated in the circuit of the common contact member E.—*July 20th*, 1931.

AERONAUTICS.

353,316. September 18th, 1930.—A VERTICAL-LIFT AEROPLANE, G. W. Windsor, 2538, Burnett Way, Sacramento, California, and A. E. Grimm, 2981, 35th-street, Sacramento.

The inventors propose to provide an aeroplane with at least three propellers, as indicated at A A A, which can be used to provide a direct vertical lift, and thus avoid the necessity for a long run on the ground in taking off. These propellers are accommodated in openings in the wings and the fuselage, and

are driven by gears and shafting from the main engine. The arrangement of this gearing is given in detail in the specification, and includes mechanism whereby at the will of the pilot

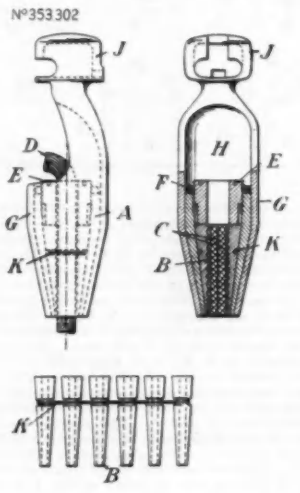


the direction of thrust of the propellers may be changed from the vertical to horizontal.—*July 23rd*, 1931.

TRANSMISSION OF POWER.

353,302. September 1st, 1930.—OVERHEAD LINE STRAINING CLAMPS, Eduard Wirschitz, 39, Goethestrasse, Munich, Germany.

The straining clamp described in this specification comprises a hollow conical member A, in which are inserted clamping wedges B with roughened inner surfaces C for gripping the conductor D, the wedges being arranged in circular formation and pressed into position in the hollow conical member A with

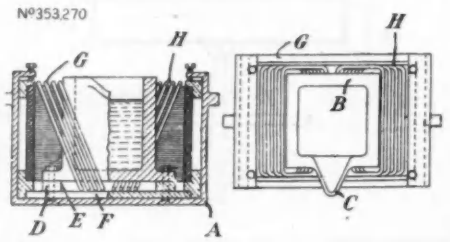


the help of a screw sleeve E. A ring F serves for securing the screw sleeve E in position. The whole is positioned within a carrying member G, provided with an insertion opening H and a drumstick socket J for suspension purposes. In order that the wedges B may be held together and yet be capable of relative movement, they are secured in a row on a flexible metal strand or lace K in the form of a chain, the members of which are spaced at equal distances apart.—*July 23rd*, 1931.

FURNACES.

353,270. August 6th, 1930.—ELECTRIC INDUCTION FURNACES, *Associated Electrical Industries, Ltd., of Bush House, Aldwych, Westminster.*

An object of the invention is to provide a novel and efficient coil structure for induction furnaces. Within the outer casing A there is a crucible B, provided with a pouring spout C at its upper edge. The bottom of the crucible is provided with lateral

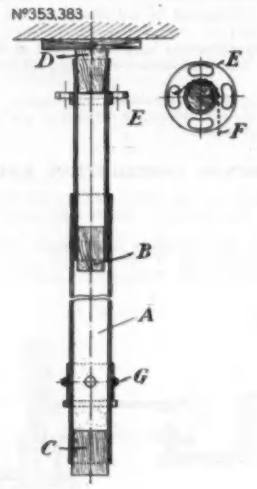


extensions D, constituting supporting lugs, and the crucible rests upon two spaced blocks E of refractory electric insulating material. The blocks E rest upon a similar plate F. Two energising coils G and H are provided, the turns in each part of the energising coils being symmetrically and oppositely inclined to the longitudinal axis of the crucible. A laminated structure is situated between the sides of the crucible B and the side walls of the casing A.—*July 23rd*, 1931.

MINING MACHINERY.

353,383. July 15th, 1930.—TELESCOPIC PIT PROPS, W. A. Beech, Brereton Hall Cottage, Brereton, near Rugeley, and J. J. Staley.

This pit prop is of the telescopic type, and is made of steel pipe packed with sand, or other small material. The packing is placed at A between the hard-wood plugs B and C, while the upper portion is also provided with a hard-wood plug D for bearing against the roof. The upper portion also has a flange E, which is drilled for the accommodation of a pulling chain F. When it is desired to withdraw the prop, the chain is wrapped round, and the pull exerted results in a partial rotation of the



top half, which disturbs the sand in the lower half and, consequently, expedites its outflow through the escape holes G. The prop then collapses and is easily withdrawn.—*July 23rd*, 1931.

METALLURGY.

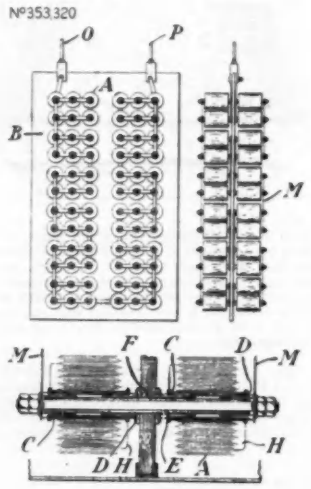
352,377. February 4th, 1931.—RECLAIMING METALLIC SCRAP, the Ford Motor Company, Ltd., 88, Regent-street, London, W. 1.

The aim of this invention appears to be the recovery and immediate utilisation of the scrap ends of alloy steel electrodes used in arc welding. It is pointed out that the value of such scrap, which may contain considerable proportions of tungsten and/or molybdenum, is considerable. The inventors consequently "grind" the scrap in a disc mill, so that it will pass a mesh of from 20 to 100. It is then heated in a deoxidising furnace to a temperature of about 1000 deg. Cent. for some 15 minutes. The material so recovered is die-pressed to form new electrodes.—*July 23rd*, 1931.

MISCELLANEOUS.

353,320. September 24th, 1930.—STATIC MULTIPLE CONDENSERS, Emil Haefely et Cie. A.G., of 353, Lehenmattweg, Bale, Switzerland.

Multiple electrical condensers consist of a battery of individual condenser elements, which are often assembled in frames and connected together in groups or batteries. With voltages up to 1000 volts, it is possible to construct each element of such a battery to withstand the full working voltage, and the desired capacity can be obtained by connecting the elements in parallel. If higher voltages are required, it becomes necessary to connect the groups of elements connected in parallel, in series, and difficulties arise in effecting the connections. The object of the invention is to overcome these difficulties. The condenser elements A of the battery are mounted on each side of a vertical carrying plate B of insulating material in such a manner that a condenser element on one side of the plate lies in the same horizontal plane as a corresponding condenser element on the other side of the plate. The condenser elements are of the wound type, and each has a core C of insulating material, by means of which it is mounted on two metallic supporting bushings D. The latter are mounted on a spindle E, which passes through two



condenser elements lying in the same horizontal plane, and which passes through an opening F in the carrying plate B. The bushings D are provided with a stop, and between this stop and the adjacent end of the bobbin C, two washers are inserted, between which the connecting strips H, leading to the poles of the condenser elements, are clamped. The spindle E is hollow, and is traversed longitudinally by a bolt, which is screw-threaded at its ends and provided with nuts. These nuts serve, on the one hand, to secure the condenser elements firmly to the carrying plate B, and, on the other hand, to ensure good electrical connection at the pole connecting strips H, and at the connecting members M, which are adapted to connect the individual condenser elements. It will be seen that by tightening the nuts the connecting members M are firmly applied to the bushings D, and between the pair of bushings and the pressure transmitting bobbin C, the washers for securing the connecting strips H are pressed together, and the whole arrangement is secured on the carrying plate B, so that a rigid structure is obtained. The connecting members M serve to connect the condenser elements in series or parallel as required with respect to the current leads O P.—*July 23rd*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY TO SATURDAY, SEPTEMBER 3RD TO 12TH.

"MODEL ENGINEER" EXHIBITION.—Royal Horticultural Hall, Westminster, S.W. 1. Daily.

SUNDAY TO SATURDAY, SEPTEMBER 6TH TO 12TH.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—Congress at Zürich.

TUESDAY, SEPTEMBER 8TH.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. Presidential address, by Mr. F. E. Rebbeck. 6 p.m.

THURSDAY TO SATURDAY, SEPTEMBER 10TH TO 26TH.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—Olympia, W. Daily, 11 a.m. to 9 p.m.

FRIDAY, SEPTEMBER 11TH.

INSTITUTE OF MARINE ENGINEERS.—At the Shipping, Engineering and Machinery Exhibition, Olympia, W. "Marine Engineering as a Marketing Proposition," by Mr. A. C. Hardy, 3 p.m.; "The History of Marine Refrigeration," by Mr. A. R. T. Woods. 6 p.m.

SATURDAY TO WEDNESDAY, SEPTEMBER 12TH TO 16TH.

INTERNATIONAL FOUNDRY CONGRESS.—Milan.

SATURDAY TO SUNDAY, SEPTEMBER 12TH TO 27TH.

INTERNATIONAL FOUNDRY EXHIBITION.—Milan.

SUNDAY TO FRIDAY, SEPTEMBER 13TH TO 18TH.

INSTITUTE OF METALS.—Autumn meeting at Zürich. For programme, see page 21.

FRIDAY TO SUNDAY, SEPTEMBER 18TH TO 20TH.

NATIONAL SMOKE ABATEMENT SOCIETY.—Annual Conference at Liverpool. For programme, see page 220.

FRIDAY TO MONDAY, SEPTEMBER 18TH TO 21ST.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—At Lady Margaret Hall, Oxford. Eighth annual conference. Friday evening, presidential address, by Professor A. M. Carr Saunders.

WEDNESDAY TO FRIDAY, SEPTEMBER 23RD TO 25TH.

INSTITUTION OF MINING ENGINEERS.—Manchester. Postponed summer general meeting.

TUESDAY TO FRIDAY, SEPTEMBER 29TH TO OCTOBER 2ND.

IRON AND STEEL INSTITUTE.—Autumn Meeting at Swansea. For programme see page 105.

LAUNCHES AND TRIAL TRIPS.

PILCOMAYO, 2000-ton drag and cutter suction dredger; built by Lobnitz and Co., Ltd., Renfrew, to the order of the Chilean Naval Commission for the Chilean Government. Just completed satisfactory speed and dredging trials at the port of Talcahuano, Chile.

STEEL HARBOUR LIGHTER; built by Richard Dunston, Ltd., to the order of Hull owners; dimensions, 75ft. by 20ft. by 9ft. 6in.; launch, July 31st.

STEAM FERRY; built by Netherland Shipbuilding Company, Amsterdam, to the order of the Dutch Government; dimensions, 34·00 m. by 13·50 m. by 4·30 m.; for ferry service between Hembrug and Buitenhuizen. Engines constructed by Messrs. N. V. Verschure and Co., Amsterdam; launch, August 1st.

STEEL HARBOUR LIGHTER; built by Richard Dunston, Ltd., to the order of Hull owners; dimensions, 75ft. by 20ft. by 9ft. 6in.; launch, August 6th.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received the contract from the General Post Office for a twelve months' contract for the supply of "Mazda" vacuum and gas-filled lamps, commencing September, 1931.

HARLAND AND WOLFF, Ltd., have recently secured orders for a passenger ferry for the Wallasey Corporation to run across the river Mersey and a twin-screw self-propelled floating crane pontoon for the South African Railways and Harbours. The order for the floating crane pontoon has been received from Cowans, Sheldon and Co., Ltd., Carlisle.

GLENFIELD AND KENNEDY, Ltd., Kilmarnock, have recently secured a contract through Gwynnes, Ltd., Hammersmith, for the manufacture and erection of all the water control equipment required on the new graving dock, which is at present under construction at Southampton, and which is intended for the use of the new 73,000-ton Cunarder. This equipment is of very large dimensions, and includes numerous sluice valves ranging from 3ft. to 10ft. in diameter.

DORMAN LONG SCHOLARSHIPS.—The result of the recent Institute of Structural Engineers' Scholarship was remarkable in the fact that the first, second and third awards were gained by young Manchester engineers. Further, these engineers are all employees of Redpath, Brown and Co., Ltd., constructional engineers, Trafford Park, Manchester. The scholarship is awarded trienially by Dorman, Long and Co., Ltd., and its object is to encourage and develop in Great Britain knowledge of structural engineering. Candidates must be members of the Institute of Structural Engineers and be under the age of thirty years. The winner of the first prize this year is to travel to Canada and on his return report on certain specified conditions of the building industry and methods and details of steel-framed construction. The winner of the first position is Mr. E. W. Bentley, the second and third being gained by Mr. D. A. Godfrey and Mr. J. B. G. Martin respectively.